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THE USE OF THE PERISCOPE IN SUBMARINE TORPEDO BOATS.

In the course of a recent debate in the French parliament the Minister of Marine said that France must take prompt and energetic action if she wishes to retain her pre-eminence in submarines, as such vessels were rapidly being constructed by England, Germany, and the United States. The French programme of 1900 included 26 submarines, most of which are now in service, 18 others will be completed in 1908, and 20 more in 1909.

In this connection the manner in which a submarine, or, rather, submergible boat attacks an enemy's ship is of interest.

The eye of the submarine, which enables the little craft to obtain its bearings while submerged and to direct itself with certainty toward its objective point, is the periscope, or optical tube. This instrument consists essentially of two totally reflecting prisms mounted at the ends of a long vertical tube, which traverses the hull of the submarine and rises to a short distance above the surface of the water. Everything within the field of view of the upper prism is reflected by the two prisms and projected in the interior of the vessel. The tube has a telescopic joint, operated by a ratchet and crank, so that it can be withdrawn below the surface of the water, if necessary to avoid detection, and it can be turned about its axis so as to bring any part of the horizon into view.

The diagram makes clear the arrangement and operation of the apparatus, and the large picture shows a submarine about to attack a battleship. The submarine remains on the surface until it has approached within a mile of its adversary. Then it sinks and continues on its course, with the aid of the periscope, to a distance of about 900 yards from the enemy's ship. At this point it retracts the periscope, which might betray its presence, and steers by the compass. After advancing about 300 yards further (as estimated from its speed and the elapsed time) or to within 600 yards of the enemy, it protrudes its periscope for a few seconds to verify the distance and direction of the latter.

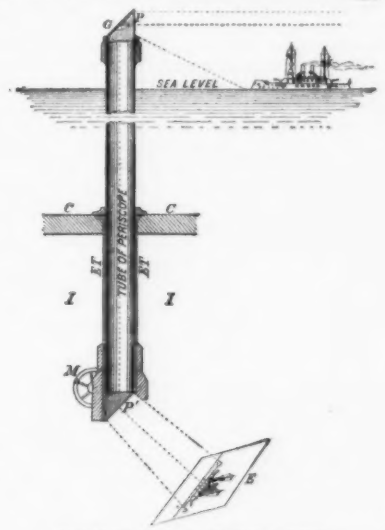


DIAGRAM OF PERISCOPE.

Then, retracting the periscope, it rushes blindly on to within about 300 yards of the warship, discharges its torpedo and instantly turns, flees to a safe distance, and rises to view the effect of its attack.—Translated for the Scientific American Supplement from L'Illustration.

STEREOSCOPIC METHODS OF SURVEYING.

In Technics an account is given of the stereo-telescope and stereoscopic range-finder made by the firm of Carl Zeiss, of Jena. The range-finder serves to determine the distances of objects with a moderate degree of accuracy, and is specially designed for use in military and naval operations. Similar principles have been utilized by Pulfrich in the design of the stereo-comparator, an appliance also made by the firm of Carl Zeiss; with this, however, the highest degree of accuracy can be obtained. The field work incidental to the survey of a considerable tract of country is limited to taking two photographs, one from each end of a base line of known length; these photographs are subsequently viewed stereoscopically, the tract of country is seen in relief, and if the distance from the observer to one particular object is known, the distances of all other objects can be determined. The advantages of a system such as this are sufficiently obvious: circumstances may arise which render it impossible or inconvenient to carry out an extended system of field observations, and in such a case the stereoscopic method can be employed, the field observation being completed in a few hours, while the rest of the survey can be carried out at leisure in the library.

The appearance of relief obtained in binocular vision depends on the retinal images formed in the two eyes being slightly different one from the other. For there to be any perceptible difference in the images, the distance between the eyes must subtend an angle equal to, or greater than, thirty seconds of arc. The distance between the eyes lies between the limits of 60 millimeters and 70 millimeters, and therefore objects nearer than 400 or 500 meters are seen in relief, while more distant objects all appear to be in a plane. In the stereo-telescope the two object glasses are placed at a distance of about a meter apart, with the result that by its aid near objects are seen in enhanced relief, while the limiting distance at which relief can be ob-

A SUBMARINE BOAT WATCHING THE MOVEMENTS OF THE ENEMY BY MEANS OF THE PERISCOPE.

served is extended to 6,000 or 7,000 meters. A stereo telescope with a greater distance between the object glasses could doubtless be constructed, but it would be very cumbersome; hence, where an accuracy greater than that obtained by the use of the stereo-telescope is desired, it is advisable to call in the aid of photography.

Let us suppose that two photographs are taken at the extremities of a base line 65 meters long; then if these photographs are subsequently viewed stereoscopically, the appearance of relief observed will be as great as if the distance between our eyes were 65 meters, i. e., about 1,000 times as great as in ordinary binocular vision.

In taking the photographs, it is of the greatest importance that the two photographic plates shall lie in the same plane. To insure this, the base line is first carefully measured out, and a sighting rod is placed at one end of this. The camera is provided with a telescope fixed in the plane in which the photographic plate lies; when the camera is set up at the other end of the base line, it is adjusted so that the sighting rod before mentioned is focused on the cross wires of the telescope, in which case the photographic plate lies in a vertical plane of which the base line is the trace. The exposure is then made, the position of the camera and sighting-rod are interchanged, and after making adjustments similar to those just described, a second exposure is made.

Paper prints of the photographs have been found to be unsuitable, since the expansion of the paper during fixing alters the relative positions of objects; hence prints are made on films supported on glass, and are subsequently viewed as transparencies. It has been found that the irregularities in the surface of the ordinary dry plate are sufficient to affect the accuracy of the results, so that the films both for the negative and the positive should be formed on optically worked glass.

WHY BRASS VALVES LEAK.

THE manufacturers of the best brass valves, we believe, test each valve under hydraulic pressure before it is sent out from the factory, yet they frequently leak when erected in the pipe lines. A recent issue of the Valve World tells some of the reasons for this fault and shows that it is due to the misuse of the erector in most cases. The points are well worth remembering and may be profitably used in the instruction of apprentices and the older men, too, perhaps. The following are the principal bad practices to be avoided:

1. Screwing a valve on a pipe very tightly, without first closing the valve. Closing the valve makes the body much more rigid and able to withstand greater strains and also keeps the iron chips from lodging under the seats, or in the working parts of the valves. This, of course, does not apply to check valves.

2. Screwing a long mill thread into a valve. The threads on commercial pipes are very long and should never be screwed into a valve. An elbow or tee will stand the length of thread very well, but a suitable length thread should be cut in every case on the pipe, when used to screw into a valve. If not, the end of pipe will shoulder against the seat of the valve and so distort it that the value will leak very badly.

3. The application of a pipe wrench on the opposite end of valve from the end which is being screwed on pipe. This should never be done, as it invariably springs or forces the valve seats from their true original bearing with the disks.

4. Never place the body of a valve in the vise to remove the bonnet or center piece from a valve, as it will squeeze together the soft brass body and throw all parts out of alignment. To properly remove the bonnet or center piece from a valve, either screw into each end of the valve a short piece of pipe and place one piece of the pipe in the vise, using a wrench on the square of bonnet; or if the vise is properly constructed, place the square of the bonnet in same and use the short piece of pipe screwed in each end as a lever. When using a wrench on square of bonnet or center piece, we recommend the use of a Stillson or Trimo wrench with a piece of tin between the teeth of the jaws and the finished brass. It may mark the brass slightly, but this is preferable to rounding off all the corners with an old monkey wrench which is worn out and sprung. As the threads on all bonnets or center pieces are doped with litharge or cement, a sharp jerk or jar on the wrench will start the bonnet much more quickly than a steady pull. Under no circumstances try to replace or remove the bonnet or center piece of a valve without first opening the same wide. This will prevent bending the stem, forcing the disk down through the seat or stripping the threads on bonnet where it screws into body. If found impossible to remove bonnet or center piece by ordinary methods, heat the body of valve just outside the thread. Then tap lightly all around the thread with a soft hammer. This method never fails, as the heat expands the body ring and breaks the joint made by the litharge or cement.

5. The application of a large monkey wrench to the stuffing box of valve. Many valves are returned with the stuffing boxes split or the threads in same stripped. This is caused by the fitter or engineer using a large-sized monkey wrench on this small part.

6. The screwing into a valve of a long length of unsupported pipe. Say, for example, that the fitter is doing some repair work and starts out with a run of 2-inch horizontal pipe from a 2-inch valve connected to main steam header. The pipe is about 18 feet long, and after he has screwed the pipe tightly into the valve, he leaves the helper to support the pipe at the other end, while he gets the hanger ready. The helper in the meantime has become tired and drops his shoulder on which the pipe rests about 3 inches and in consequence the full weight of this 18-foot length of pipe bears on the valve. The valve is badly sprung and when the engineer raises steam the next morning the valve leaks. When a valve is placed in the center of a long run of pipe, the pipe on each side, and close to the valve, should be well supported.

7. The use of pipe cement in valves. When it is necessary to use pipe cement in joints, this mixture should always be placed on the pipe thread which screws into valve, and never in the valve itself. If the cement is placed in the valve, as the pipe is screwed into the valve it forces the cement between the seats and disks, where it will soon harden and thus prevent the valve from seating properly.

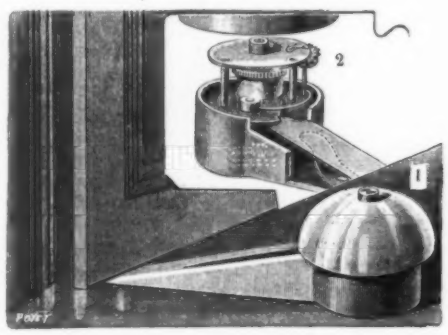
8. Thread chips and scale in pipe. Before a pipe is screwed into a valve it should be stood in a vertical position and struck sharply with a hammer. This will release the chips from thread cutting, also loosen the scale inside of pipe. When a pipe line containing valves is connected up, the valves should all be opened wide and the pipe well blown out before they are again closed. This will remove foreign substances which are liable to cut and scratch the seats and disks.

9. Expansion and contraction. Ample allowance must be provided for expansion and contraction in all steam lines, especially when brass valves are included. The pipe and fittings are much more rigid and stiff than the brass valves and in consequence the expansion strains will relieve themselves at the weakest point, unless otherwise provided for.

10. The use of wrenches or bars on valve wheels to close same tightly. This should never be done, as it springs the entire valve and throws all parts out of alignment, thus making the valve leak. The manufacturer furnishes a wheel sufficiently large to properly close against any pressure for which same is suitable. If the valves cannot be closed tightly by this means, there is something between the disks and seats or they have been cut or scratched by foreign substances.

SAFETY CATCH FOR DOORS.

THE accompanying engraving represents a simple de-



SAFETY DOOR CATCH.

1. Position of the wedge for keeping a door closed. 2. Details of the alarm bell.

vice for preventing a bedroom door from being opened from the outside. Between the floor and the bottom of a door there is always a slight space into which the extremity of a wedge can be shoved. If the door be pushed from the exterior, it will bear against the wedge, and so much the harder, too, in proportion as the push is stronger. The inventor of the catch represented has added to the wedge an alarm that operates at the least pressure. With this object in view, the upper part of the wedge (No. 1) is formed of a strip of metal constituting a spring, the extremity of which engages the hammer of an alarm bell mounted at the end of the wedge (No. 2). It will be seen that if the door is pushed, it will at once exert a pressure upon the spring and free the bell hammer. The apparatus, upon the whole, is very simple and compact, and will prove of great utility, especially to travelers. It is the invention of M. Lourdilliat, of Paris.

LOCOMOTIVE SUPERHEATERS—PRACTICAL DIFFICULTIES IN THE USE OF SUPERHEATED STEAM.

IN view of the importance of this subject the remarks recently made by Mr. W. F. M. Goss, director of the Purdue University Engineering Laboratory, are of interest. He says that as long ago as the early sixties superheaters were in use upon certain steamers operating on the Atlantic coast. The value of such arrangements were not at all questioned by those concerned with their operation, and elaborate tests by Isherwood served to confirm the popular impression. But the superheaters were difficult to maintain, even though the steam pressure was no more than 40 pounds, and notwithstanding the advantage derived from their use, the trouble arising from them led to their gradual abandonment upon the steamers referred to.

In 1877 a series of elaborate tests were conducted by Mr. George B. Dixwell upon a small Harris-Corliss engine when supplied with saturated and superheated steam. These, while confirming previous conclusions as to the advantage of superheated steam, did not at once serve to enlarge American practice in connection therewith. In recent years, while superheaters have occasionally been used in various classes of service, they have gained no footing in our practice, and gradually American engineers have come to believe that the cost of their maintenance quite offsets the advantage to be derived from their use. If, it is argued, the maintenance of the superheater gave trouble when steam pressure was only 40 pounds, and the temperature of the superheated steam no more than about 400 deg. F., how much more difficult is the problem to-day when the temperature of saturated steam approaches 400 deg. and that of superheated steam to be effective must not be less than 600 deg. F. This view is well represented by Prof. Peabody in his text-book on "Thermodynamics," which is as follows: "Whenever superheated steam has been used so as to give a notable gain in economy, the superheating has been accomplished in a separate apparatus, which has taken the form of a coil of pipe exposed to the products of combustion beyond the boiler. Now, it is the accepted experience of boiler makers that surfaces exposed to the fire must be of moderate thickness or they will rapidly waste away. Thus, it is not desirable to make furnace-flues more than half an inch thick, and if they are made thicker, they are liable to waste away until they are reduced to about that thickness. Plates and tubes if thin enough endure long service in a boiler when exposed to the fire because they are kept at a moderate temperature by the water in the boiler. If steam is to be superheated strongly in a coil of pipe or other device which is exposed to hot gases, the metal of the superheater must be strongly heated and is sure to waste away rapidly. There is no material that can stand long service when exposed at once to a high pressure and a high temperature. There is little risk, therefore, in predicting that all superheating devices now used will eventually be discarded for this reason."

While it is true that occasionally during the past twenty years superheating has been resorted to in connection with stationary plants of unusual significance, enough has been said to show that American engineers threshed out the problem of superheating many years ago, and have since been content to let the matter rest undisturbed. Very recently, however, it has again occupied their attention, and just now it is a subject of more than ordinary interest to locomotive designers. It is but fair to add that this interest has been greatly stimulated by reports from abroad.

RECENT DEVELOPMENT IN THE USE OF SUPERHEATED STEAM.

Abroad, and especially in Germany, for more than a decade there has been a great awakening of interest in superheated steam. The technical schools of Germany have for ten years past been experimenting with large superheaters in connection with their experimental engine plants, and in their practice, as well as in their more scientific work, the Germans have been and are devoting themselves to the problem of superheating. Among those who have had a conspicuous part in this movement, perhaps none have been more energetic or successful than Herr Wilhelm Schmidt. Some ten years ago, Herr Schmidt began the introduction of stationary boilers and engines designed for the generation and use of superheated steam. The Schmidt system as applied to stationary plants involves special construction both in boiler and engine, by means of which a consumption of less than 1.7 pounds of coal per horse-power hour has been obtained, while in the case of one plant, the results of which have come under the writer's observation, the consumption was reduced to 1.02 pounds per hour. This is a record of high performance.

The Schmidt stationary boiler has a vertical shell within which is arranged a large corrugated fire-box and combustion chamber, extending approximately two-thirds of the height of the shell. The grate has a smaller area than the cross-section of the fire-box, the difference being effected by a few courses of fire-brick which make up a cylindrical lining for a short distance above the grate. Higher up, the combustion chamber is crossed by circulating tubes of considerable diameter, the surface of which, together with that of the corrugated tube making up the fire-box and combustion chamber, constitutes the direct heating surface. From the top of the combustion chamber a single flue of considerable diameter opens out through the upper head of the boiler. This flue receives the products of combustion from the fire-box and delivers them to a superheater arranged above the boiler. The superheater consists of pipe 2.4 inches in diameter arranged in a series of flat coils, one above the other, there being as many as twelve coils, while above these superheating coils are other coils forming a feed-water heater.

The action of such a device is apparent. The comparatively small amount of heating surface and the short and direct passage between the furnace and superheater serve to supply the latter with gases at a high temperature, while the extent of superheating surface and the presence of the feed-water heater beyond serve to reduce their temperature to satisfactory limits before they are allowed to escape into the chimney.

Encouraged doubtless by his success in stationary practice, Herr Schmidt has extended the application of his system to locomotives, with the result that from four or five superheating locomotives of a more or less experimental character which were placed in service on the Prussian State Railway, the number has now been increased to more than fifty. It is claimed that the performance of these locomotives is 25 per cent better than that of similar locomotives using saturated steam.

Inspired by German success, American builders and

railroad companies have entered upon a period of cautious experimentation. A Canadian railroad, which has been operating one or two superheating locomotives for several years, has recently given orders for a considerable number of such machines. Several of the larger roads of this country are operating one or more superheating locomotives, and the indication is that many more will be forthcoming. For the most part, practice in this country has followed closely the lines of the Schmidt design, though recently certain modifications of this design have appeared.

LOCOMOTIVE SUPERHEATERS.

The different forms of superheaters which have thus far been placed in service involve no material change in the exterior outline of the locomotive. Their application in all cases leads to some loss in the extent of direct-heating surface. Four forms which thus far have attracted public attention may be described as follows:

The Schmidt superheater involves a flue 10 inches or 12 inches in diameter, extending from the fire-box to the smoke-box along the lower portion of the barrel of the boiler. This flue displaces from twenty to thirty of the usual tubes. Its purpose is to deliver to the superheater located in the smoke-box a considerable volume of furnace gases. The large size of the tube permits the delivery of the gases at a high temperature. The construction is such that while the gases from the smaller tubes of the boiler are free to pass directly up the stack as in the ordinary locomotive, those from the large tube pass into the casing of the superheater within which they circulate around the heating tubes of the superheater, passing upward on either side to points near the base of the stack, when they emerge from the superheater and mingle with the gases of the smoke-box.

The superheater has the general form of a horse-shoe, the toe-calk of which is downward. Its tubes are arranged within a casing between suitable headers. The connections are such that all steam passing the throttle of the locomotive goes to one of the headers, thence by one-half the whole number of tubes around the horse-shoe to the other header, thence by the remaining tubes back to the first header from which it is conveyed to the cylinders. In this passage of the tubes of the superheater, the temperature of the steam is raised to 500 degs. or 600 degs. F., which is from 125 degs. to 225 degs. above the temperature of saturated steam at usual boiler pressure.

In the Schmidt improved superheater the nesting of the superheater tubes in the front end is abandoned for a system of small return tubes arranged within certain of the fire tubes which are somewhat enlarged to accommodate them. The ends of the fire tubes are contracted where they join the fire-box sheet, and the tubes of the superheater are threaded into return fittings. In this construction, the temperature to which the heating tubes are exposed is determined by the nearness they are allowed to approach the fire-box. Steam from the boiler passes into a large double-chambered header, which extends across the smoke-box. From the chambers in this box the steam passes down into one end of the small pipes, thence back to the return bends near the fire-box and back to the compartments of the header from which point it is conveyed to the cylinders. A damper serves to control the flow of furnace gases through the superheater. It is so pivoted and weighted that it remains closed except when the steam is being used in the engine cylinder, thus protecting the superheater from the action of the fire when no steam is being used in the engine cylinder. Whenever steam is admitted into the valve box, however, it also enters the cylinder which opens the damper.

The Pielock superheater consists of a box built entirely within the barrel of the boiler and inclosing a certain length of the usual tubes in such a way as to make the inclosed portions of the tubes available as superheating surface. The tubes are lightly rolled into the end plates of the superheater-box to exclude the water. It is stated that no trouble is experienced in preventing leakage as the pressure within the box and in the boiler is essentially the same, and the joints need only be made tight against the static head of the water.

Moreover, no danger results from such leakage, since if the amount is small, the water is evaporated, and if large, it does not disable the locomotive but merely interferes with the action of the superheater. A tube passing from the bottom of the superheater out through the shell of the boiler is fitted with a drain cock, which may be used to ascertain if the superheater is tight. No special fastening of the superheater box is necessary, as the box nearly floats and the surplus weight is taken by the large number of tubes to which the box is fastened.

Steam is taken from the dome of the boiler, is conveyed to the heater box where it circulates among the tubes, after which it passes to an inclosed chamber in the dome, thence past the throttle valve to the cylinders. To promote the circulation of steam within the superheater, the box is divided by vertical partitions in several compartments which are joined by openings placed alternately at the top and bottom. It is evident that the degree of superheating may easily be regulated by varying the length of the superheater or its position relative to the fire-box.

It will be of interest to note that the Von Borries compound locomotive, exhibited at the Louisiana Purchase Exposition by the Hanover Locomotive Works and tested by the Pennsylvania Railroad Company, was fitted with a Pielock superheater.

THE JOURNAUX TRACTOCYCLE.

IN his tractocycle, M. Journaux seems to have endeavored to obtain a practical riding rather than racing machine, and one that, through a disengaging gear, should permit of using pedals, to the exclusion of the motor, whenever desired, for traversing congested streets or for any other purpose.

The motor is of 1¼ horse-power, and, like the carbureter, the spark advance, the decompressor, and the control of all these parts, is placed in front upon a reinforced fork-head especially designed for the reception of the whole, and upon which it is firmly held by a coupling plate that it suffices to unscrew in order to dismount it.

The front wheel is driven by a twisted belt that can be rendered taut or slack, according to circumstances and requirements, for throwing the motor either into or out of gear, through the intermedium of a small toothed lever placed at the upper and central part of the handle bar. This lever controls a drum situated under the fork-head, above the mud guard, and over which passes the belt, which is kept taut by a jockey pulley mounted upon ball bearings. This, in sliding in a guide, bears more or less, according to the position given the lever, against the slack portion of the belt, and thus performs the part of a clutch. A small reservoir, provided with a hand pump, and secured to the steering tube of the frame, permits of assuring the lubrication while running.

A case placed in the lower part of the frame contains the gasoline reservoir, the coil and the battery of accumulators. A small pump of the tire-inflating type is secured to the top of the reservoir and permits of producing a slight pressure upon the gasoline in order to cause it to ascend to the carbureter and keep it supplied. This pump is so arranged that it can be operated while under way. The two reservoirs are connected with the motor by a flexible tube. The starting is very easily effected, without any effort on account of the arrangement of the clutch. Two kicks of the pedal suffice to start the motor; the velocity of

THE JOURNAUX TRACTOCYCLE.

which is regulated at will through the manipulation of the sparking and decompressing devices placed within reach of the hand; all the operations being performed without releasing the handle bar. Such arrangement of the parts has been adopted in order to render easier the management of the machine, which weighs but 60 pounds.

The front wheel, which is the driving and steering one, assures perfect stability and freedom from skidding; while the hind wheel is the trailing one, whence the name of tractocycle.

The lowering of the center of gravity, due to the place selected for the housing of the two-gallon gasoline reservoir and the electric plant, amply compensates for the slightly elevated position of the motor, although the weight of the latter (15 pounds) is less than that of a tourist's pack. Besides, the exposure of the motor in front greatly favors its cooling, and assures its regularity of operation. The form of the frame is such that the rider has merely to stretch his legs in order to have his feet rest upon the ground while he sits in the saddle.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from L'Automobile.

THE SPECIFIC HEAT OF IRON AT HIGH TEMPERATURES.

A KNOWLEDGE of the specific heat of iron at high temperatures is valuable, since it throws light on the various molecular transformations which occur when heated iron is allowed to cool. Dr. J. A. Harker, of the National Physical Laboratory, has determined the total heat of iron up to 900 deg. C. by heating the specimen in an electric furnace, the temperature of which is determined by a resistance thermometer, and dropping the iron into a water calorimeter. To avoid the oxidation of the iron, which occurs when the heated metal comes into contact with the water, the following method was employed: Within the calorimeter, and partly immersed in the water, is a brass tube closed at its lower end, and containing magnesia. The specimen of iron to be tested has the form of a cylinder slightly smaller than the brass tube, and is dropped, when heated, into the magnesia. The extreme flocculence of the powder allows the iron to sink at once to the bottom of the tube, becoming immediately covered up by the magnesia.

SPECIFIC HEAT OF SUPERHEATED STEAM.

AN interesting paper on the specific heat of superheated steam was read by Mr. A. H. Peake before the Royal Society on March 30. In the first series of experiments described, the rise of temperature due to throttling was observed, and from this the specific heat of the steam was calculated. Mr. J. H. Grindley has previously used a similar method, but that experimenter concluded that steam taken from a saturator contains an appreciable amount of condensed moisture, since the steam, when caused to expand through a small orifice, so that its pressure only fell to a small extent, showed no rise of temperature. After a considerable amount of experimental work, Mr. Peake has succeeded in obtaining conditions such that the smallest possible expansion of the steam produces superheating, and he therefore concludes that the steam he used was quite dry. After observing the extent of the superheat for various expansions, the specific heat at constant pressure of dry steam was calculated from Regnault's tables for the total heat of saturated steam; as a result, the specific heat appeared to vary rapidly with the temperature, being 0.43 at 230 deg. F., and rising to 1.0 at 350 deg. F. These results led the author to suspect the accuracy of Regnault's tables, and he accordingly determined the specific heat of superheated steam by a direct method. Dry steam was passed at a measured rate through a vessel containing a coil of wire heated by electricity; the current and fall of potential in the wire were then observed, and from these the energy dissipated in heat per second was calculated; on comparing this with the number of grammes of steam passing per second, and the rise in temperature of this steam due to the heat imparted to it, the specific heat of the steam was determined. It was found that the specific heat of superheated steam at constant pressure is practically constant, being equal to 0.46; if there is any variation of the specific heat with the temperature, this must be much less than that determined from Regnault's tables, so that these must be considered untrustworthy.

THE INTENSITY OF PRESSURE OF WHEELS ON THE ROAD.

THE wearing qualities of a road depend largely on the intensity of pressure of the wheels per unit area of surface. The intensity of pressure of the wheels of a loaded omnibus or other large vehicle is much greater than that of a steam roller, so that after a road has been properly made and steam-rolled, the wheels of heavy vehicles will "dig in" and form ruts. A roller, in passing over road metal formed of stones and sand, does not bear equally over the surface, but rests to a great extent on the stones, leaving the sand comparatively soft, so that heavily laden narrow wheels easily cut the road up. A pneumatic tired wheel, having a yielding surface, exerts practically equal pressure all over its area of contact; while progressing over the road, it to a great extent absorbs any obstacles it may meet, and consequently does not hammer the road to anything like the extent an iron or even solid rubber tire does.

The diameter of wheels has a great influence on the "hammering" action, as has also the efficiency of springing of the vehicles.

A larger wheel occupies a longer period in rising onto and falling from an obstacle, and consequently the blow on the road is less than with the same load on a wheel of smaller diameter and the same width.

To keep the roads in good order, it is imperative that the wheels of all vehicles should be proportioned both in diameter and width of surface, not only to the load to be carried, but also to the speed at which the vehicles are allowed to travel.

This does not apply to wheels shod with rubber or tires of other yielding material, as the limit of elasticity of the tire substance automatically regulates the permissible intensity of pressure and keeps it well within what macadam roads, as at present constructed, can endure.

THE GOVERNING OF GAS ENGINES.

DURING the last few years we have heard a great deal about the growth in size of gas engines. In England those makers who have produced small engines on a large scale have done best, and in all these small engines the "hit-and-miss" system of regulation is employed. In this method there are certain advantages and disadvantages. It is certainly less liable to get out of order than any other type and it governs well, for the variations of speed which result from alterations of load are almost negligible. Moreover, the lowest consumptions of gas are secured at different speeds. The defects of the system cannot, however, be overlooked. After a stroke during which there has been a "miss" the following explosion is usually more powerful, and thus violent explosions are produced, the results of which are most injurious to the working parts of the engine. Intermittent explosions must produce irregularities in the revolutions of the flywheels, and such irregularities cause trouble when dynamos are driven. Very heavy flywheels are used, but however well balanced such wheels may be the mechanical efficiency of the engine is reduced on this account.

For large gas engines the "hit-and-miss" system is

not used, but attention has been directed toward varying the quantity of the explosive mixture, and certain English makers use a system of throttling. It is obvious that variable admission means also variable compression, and this interferes with the prompt ignition of the mixture. The most recent improvements have involved mechanism, by means of which the variable admission of the constant mixture has been combined with an additional admission of air so that constant compression may be obtained.—Engineering Times.

[Continued from SUPPLEMENT No. 1584, page 25378.]

RESERVOIR, FOUNTAIN, AND STYLOGRAPHIC PENS.—VI.*

By JAMES P. MACINNIS, A.M.Inst.C.E., M.Inst.Mech.E.

FOUNTAIN PENS.

ANOTHER pen with a flexible rubber ink reservoir was patented by Reschke & Leutner, in 1886 (4368), and is shown in section in Fig. 129. The tubular holder or casing contains a reservoir, *F*, of India rubber or other elastic material. This is attached at its upper end to a screwed rod, *B*, and a knob, *A*, by which it may be twisted to expel ink or air. A stud or pin, *D*, is placed at the side, and the reservoir, *F*, may be compressed by this means. Ink is delivered to the nib, *N*, through the passage, *G*, to *C*. The tongue, *K*, acts as a spring to grip the nib.

Fig. 129.

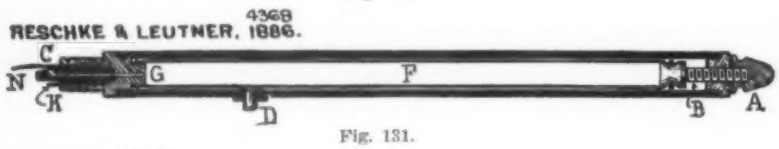


Fig. 131.

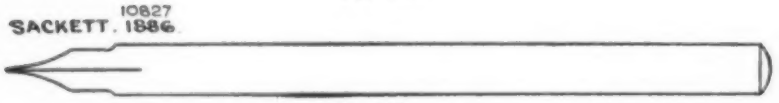


Fig. 133.

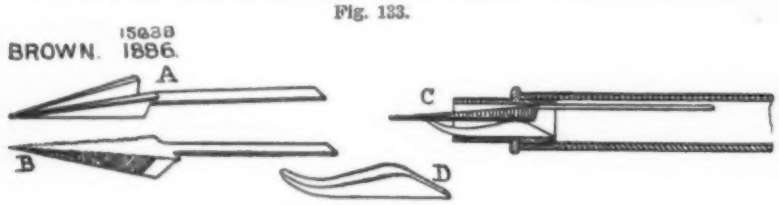


Fig. 135.

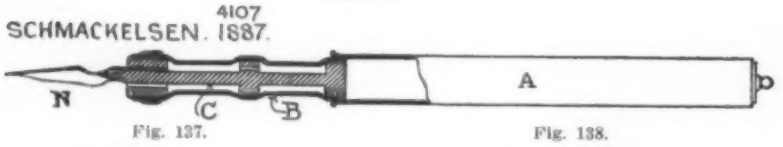


Fig. 137.

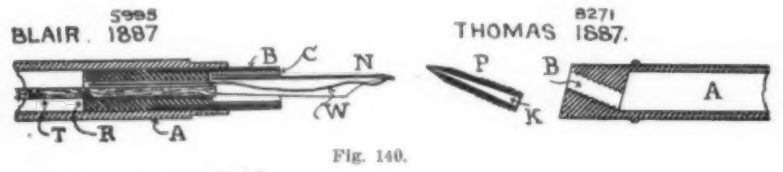


Fig. 140.

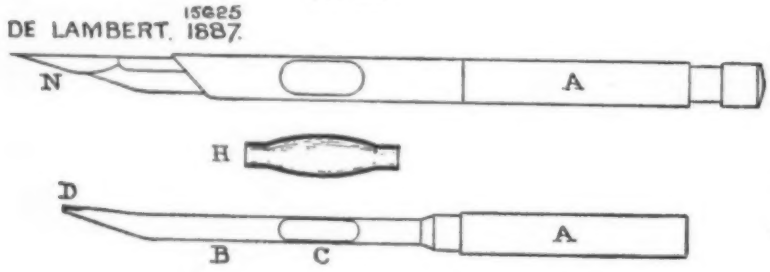


Fig. 130.

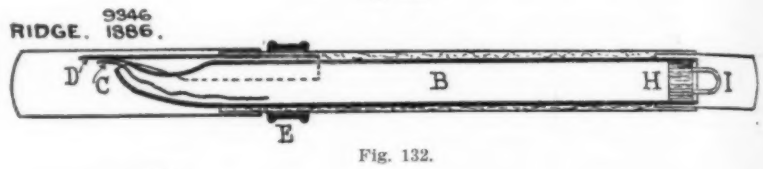


Fig. 132.

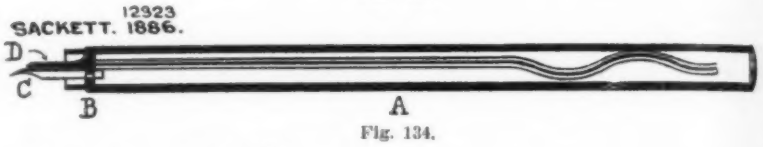


Fig. 134.

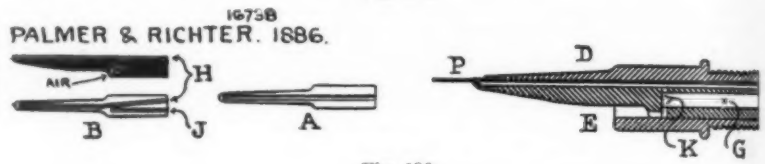


Fig. 136.

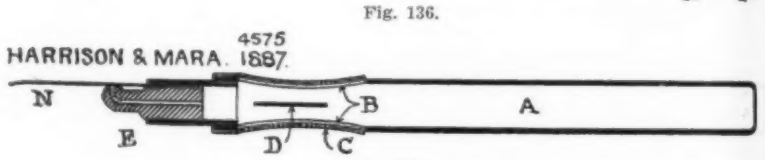


Fig. 139.

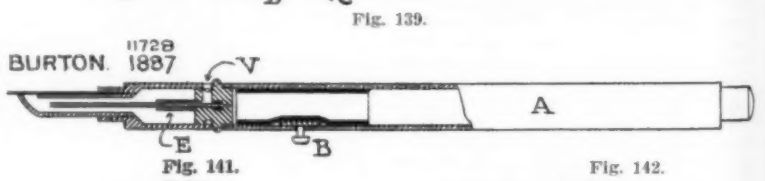


Fig. 141.

Fig. 142.

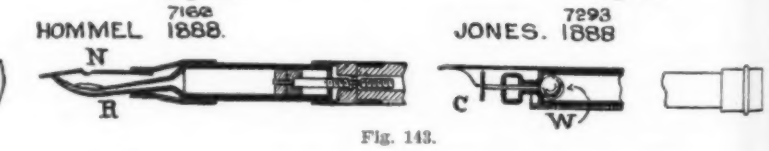
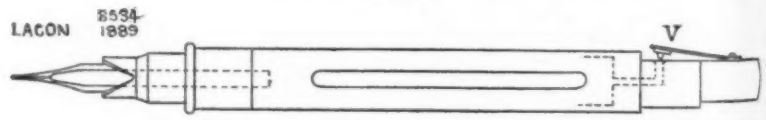


Fig. 143.



In Ridge's pen of 1886 (9346), shown in Fig. 130, the reservoir, *B*, is made of glass, drawn out at one end to a point through which a wick, *C*, projects against the nib, *D*. A movable plug, *H*, closes the upper end of the reservoir, and this is provided as shown with a wire loop, *I*. This plug may be pushed down the reservoir to the lower end, and raised to the position shown by a hooked rod, and thus the pen may be charged with ink. To protect the glass tube it is covered with an outer case, into which it is fitted by suitable packing. A sliding ring, *E*, is provided as a means of holding the nib in position.

Mr. G. H. Sackett's patent, August, 1886 (10827), shown in Fig. 131, is an exaggerated barrel pen, made of metal, closed at its upper end and terminating at its lower end in a writing nib having an extra long slit. The lower end of the tube is closed also, that any ink contained in it can only escape through the slit, to the point of the nib, and then only during the operation of writing.

In Sackett's patent of 1886 (12323), shown in Fig. 132, the tubular reservoir, *A*, is closed at one end, and provided at the other with a movable diaphragm, *B*, having a crescent-shaped slit for receiving the nib, *C*, and for allowing the proper flow of ink. A tongue, *D*, is attached so as to rest on the back of the nib, and a face which comes in contact with the nib, *P*. A channel is provided for the passage of the air which enters through openings at *K*, into the cavity, *G*. At *A* is shown a plan of the feed bar, with the channel or groove along its upper surface. A modified form of feed bar is shown at *B*, the upper view being in section. In this, ink travels along the groove, *H*, to the nib, while air enters at the point indicated by the arrow, and passes along the shorter groove, *J*.

Fig. 135 is the invention of J. Schmackelsen in 1887 (4107). This is a combination of both rigid and flexible ink reservoir. The reservoir, *A*, is prolonged by the addition of a flexible tube, *B*, stiffened by a rod, *C*, provided with bosses supporting the flexible tube at intervals. Ink passages are formed in the bosses as shown. A ring at the end forms a termination to the flexible tube, and supports the front end of the rod, *C*, thus forming a holder to contain the nib, *N*. The rod, *C*, also carries ink to the nib. The flexible tube collapses, more or less, with the pressure of the fingers of the writer, and ink is thus forced forward.

Another flexible ink reservoir is here shown in Fig. 136, Harrison & Mara, 1887 (4575). The tubular holder, *A*, is of metal, and is provided with openings, *B*. These openings are covered with India rubber or some other elastic material, *C*, while the sides are stiffened by a partition, *D*. A section of the feed bar, *E*, shows the method of delivering ink to the nib, *N*.

In Blair's pen of 1887 (5995), a part section of which is shown in Fig. 137, a corrugated tube, *B*, has a rubber tube, *R*, pushed in at the rear end to form a tight joint with the holder, *A*, and a second corrugated tube, *C*, inserted at the front end of the tube, *B*, provides a holder for the nib, *N*. The ink travels along the metal strip, which is held in position by the absorbent wooden rod, *T*. This rod, *T*, serves also to absorb any excess of ink in the passage when the pen is out of use.

In Fig. 138, W. J. Thomas, 1887 (8271), it will be seen that the reservoir, *A*, is perforated by an opening, *B*, at an inclination from the axis of the pen. Into this is screwed a short tube, *P*, through which the ink flows to the nib. This tube has a tapering bore, as shown in the section at *K*, and a piece of cane is inserted therein. The nib is held in position by a bent plate, neither of which is shown on the drawing. The object in placing the feed tube at the angle shown is to prevent leakage when the pen is placed on a desk, and the holder is so weighted as to automatically keep the pen in the position indicated. Air is admitted at the top of the reservoir.

Again, in Fig. 139, is a flexible reservoir, patented by W. E. Burton, in August, 1887 (11728). A short rubber tube is fixed inside the outer protecting tube, *A*, and may be operated from the exterior by the stud and plate, *B*. Pressure on the stud compresses the flexible tube and forces a small quantity of ink to the lower end of the pen, as shown, while air is admitted at *V*. On reversing the pen, the ink from the pen flows backward to the chamber *E*.

The flexible ink reservoir is again shown in Fig. 140, patented by de Lambert in 1887 (15625). The tubes, *A*, *B*, form the reservoir. In *B* is a slot or opening, *C*, into which a small sponge is inserted, and a flexible rubber sleeve, *H*, is slipped over this opening. Another metal tube is placed over this, as shown in the drawing of the complete pen, and this also has a slot or opening through which may be seen the rubber sleeve, *H*. Pressure with the finger upon the rubber sleeve forces ink through the opening at *D* to the nib, *N*.

In Fig. 141 we have Hommel's patent of 1888 (7166), being another instance of the introduction of a mechanical arrangement for drawing in or discharging ink by means of a piston. Ink is supplied through the fine tube, *R*, to the nib, *N*.

In the invention of G. H. Jones (7293) May, 1888, the reservoir consists of a glass tube, drawn to a fine point at one end, and covered at the other after the manner of a drum with some elastic material, on pressing which ink is forced out through the point to the nib. The reservoir is filled by heating the tube and then dipping the point in ink.

Fig. 142 shows a self-acting device by the same inventor for closing the ink outlet when the pen is re-

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versed. The disk, *C*, falls down upon the orifice; *W* is a weight provided to insure its doing so.

There appears to be nothing particularly striking in this pen (W. Guthrie, 1888, 10934). In using the pen, it is first held with the point upward, and then inverted, when a drop of ink flows to the nib. When this is used the pen is again held point upward, and so on.

In the invention of E. Lacon, in 1889 (8534), the reservoir is of glass or of other transparent material, and the other protecting cover is slotted, so that the quantity of ink within may be readily seen. Fig. 143 shows the general appearance of the pen. A valve is provided for controlling the admission of air. A ring is placed on the upper end, capable of sliding up and down for the purpose of opening or closing the air inlet valve, *V*.

In Fry's patent of 1889 (10435), the reservoir is closed by a plug, and the feed bar is perforated by minute holes, so formed that the edges of the opening are in contact with the nib. For the purpose of regulating the flow of ink into the feed tube a plug is provided, which may be screwed down to close completely the passage to the feed tube. When unscrewed the ink flows through the orifice.

Fig. 144 shows Pickhardt's pen of 1890 (33), the reservoir of which is made of glass drawn to a fine point. Within the tapering point is placed a tube, *C*, of gauze or woven asbestos, the end of which is in contact with the under side of the nib, *N*. A modification is shown in Fig. 145, where the point or feed tube, *A*, is of vulcanite, and, instead of the gauze tube, *C*, of Fig. 144, a tongue is cut from the nib, *N*, which is in contact with, or just enters, the ink outlet.

H. Pearse designed a pen in 1890 (59), which instead of having the familiar piston and its rod is fitted with nib. A folded wire, *G*, passes from the feed tube to the reservoir.

The Eagle Pencil Company, in 1890 (15053), describe a pen in which the nib is held between the barrel and the ink conductor. At the rear end of the barrel is an India-rubber tube connecting it to the reservoir. The ink conductor or feed bar has one or more longitudinal grooves, and a saw-cut under the point renders it more flexible.

In Hyde's patent of 1890 (6094) the feed tube is cut with a number of transverse slits to render it flexible. Fig. 148 shows a longitudinal section of the nib socket, which is formed with openings for the nib, *D* (as shown in cross section), a feed tube, *G*, and an opening, *E*, for the admission of air. A longitudinal slit is provided immediately over the nib for the delivery of ink.

The reservoir in Robinson's patent of 1890 (8629), shown in Fig. 149, is provided with a plug, *B*, adapted to hold the nib, *D*. This plug is provided with a groove above the nib, and in which is placed a wire or strip, *F*, flattened at the end in contact with the nib. A filling piece is placed in the groove, so that ink flows only in the narrow space between the wire and the surrounding walls.

In Shaw's patent of 1891 (6398), the reservoir is closed at one end, and has two openings at the other for the inlet of air, and for the outlet of ink, respectively. The lower, or penholder part, screws on the reservoir, and has openings corresponding to the inlet and outlet openings. It is hollowed out to receive the nib part. The nib is covered with a plate, between which and the nib the ink flows, air entering at an opening provided.

In the invention of Krulis & Adutt of 1891 (3523), serves as a feeder for the ink from the reservoir to the nib, small passages (not shown on the drawing) being formed at its side for the purpose.

In Fig. 152, 1892 (2128) is shown the feed arrangement of Walke & Davis. Air tubes, *E* and *F*, are fitted within the point section, *B*. The tube, *E*, is wide at the upper part to fit the bore, *B*, and amount of less diameter at the lower part to receive the nib and ink conductor, *D*. A groove, *H*, is formed in the tube, *E*, to allow ink to flow to the conductor. Within the tube, *E*, is fitted the adjustable tube, *F*, having a small bore for the gradual admission of air to the reservoir.

A piston of peculiar construction is used in the pen shown in Fig. 153 (3325, Blake, Pratt & Taylor, 1892). It is formed of a tube, *B*, having a longitudinal slit or saw cut, and filled with India rubber to render it elastic and form a tightly-fitting joint. Attached to the piston is a casing, *G*, which slides with the piston. The feed tube, *C*, is fitted with a valve, *V*, to regulate the ink flow and with a mid-feather, *F*, to feed the ink to the nib.

In Fig. 154 L. Lowenstein, 1892 (17393), the tube, *A*, is formed with internal screw threads at each end. In the lower end two plugs, *B* and *C*, are screwed. One plug, *B*, has two holes, and a conical projecting portion, *E*, which enters the opening in the plug, *C*. The position of the lower plug, *C*, can be altered by means of a milled head, *O*, and the amount of opening thereby regulated. Ink flows to the nib, *N*, through a passage provided. An air inlet is arranged at the upper end of the reservoir, so that when the cap, *T*, is slightly unscrewed air may enter through the channels formed in the plug, *P*. To fill the pen with ink, the plug, *P*, is removed.

In the invention of W. Higgs, patented in December,

Fig. 144.

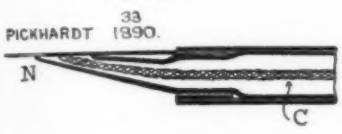


Fig. 145.

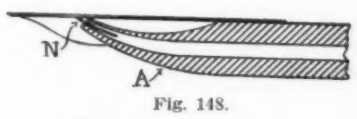


Fig. 146.

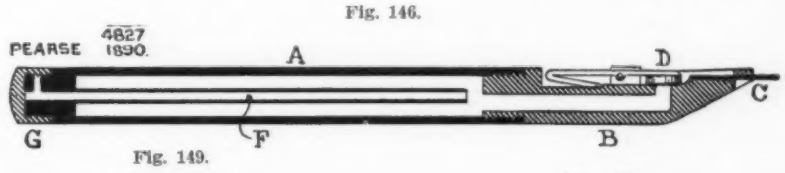


Fig. 147.

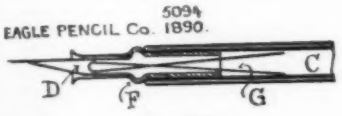


Fig. 148.

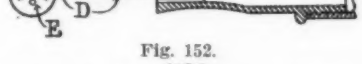


Fig. 149.

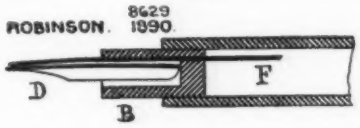


Fig. 150.

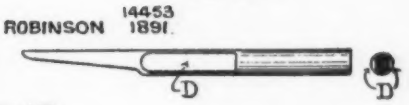


Fig. 151.

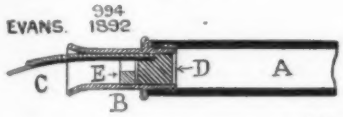


Fig. 152.

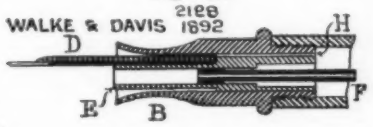


Fig. 153.

Fig. 154.

Fig. 155.

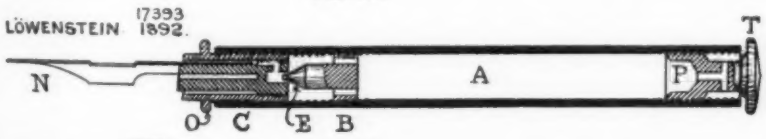


Fig. 156.

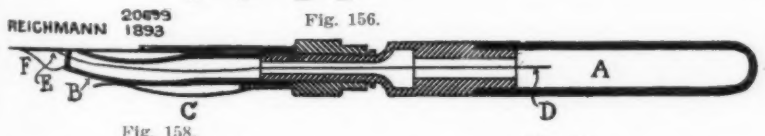


Fig. 157.

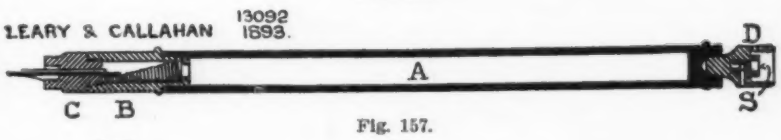
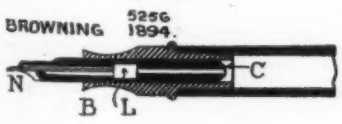


Fig. 158.

Fig. 159.



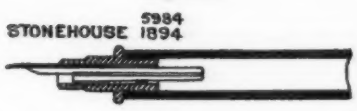
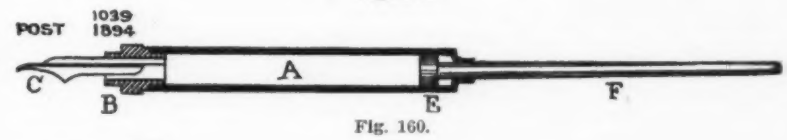
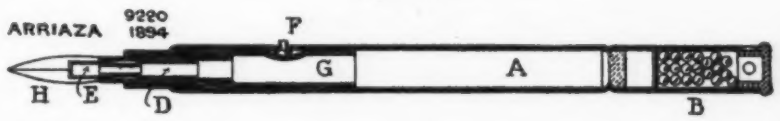


Fig. 160.





a plunger screwing into the reservoir for its entire length, as a means of forcing ink to the nib.

Falconnet and others took out a patent in 1889 (7784), for a piston type of pen, the ink being expelled from the reservoir by the movement of the piston. The piston has a threaded perforation, through which passes a rod, the rear end of which is secured to a cap, and as the cap is turned, so the rod is also turned, and by reason of the screw the piston is thus made to traverse the interior of the reservoir. The ink flows to the nib through a tapering tube or feed bar which is slotted under the nib.

In the invention (3252) of Hill & Appleton, 1890, the reservoir is of gutta percha (placed within a metal tube), and is open at one end, and closed at the other. Into the open end is screwed the feed bar, which is hollow, and has two small openings for the admission of air and outflow of ink to the nib placed immediately over them.

In Fig. 146 Pearse's patent of 1890 (4827), the nib, *C*, is carried on a part, *B*, screwing into the reservoir, *A*. The outflow of ink is regulated by a valve, *D*, operated by a lever as required. Air is admitted at the other end of the pen through a tube, *F*, which is covered by the cap, *G*, when out of use.

This pen, Fig. 147, the production of the Eagle Pencil Company, 1890 (5094), is described as being formed in three parts, the reservoir, the barrel, and the feed tube. The reservoir, *C*, is connected to the barrel by an elastic tube, *F*. The feed tube is formed with a swelling or shoulder, which prevents it slipping too far forward, and it is slotted for the ink to flow to the the ink is contained in the reservoir, and flows to the nib through a tube. This tube may be carried by the valve carried on a rod fixed to a plug fitted in the upper end of the reservoir. An elastic rubber plug or spring forces the plug outward, and thus keeps the valve normally closed.

Mr. Robinson (1891, 14453) has here designed a feed bar of solid construction, formed with two flattened surfaces as shown in Fig. 150, at *D*, one on either side, to allow of the passage of ink from reservoir to the nib. Mrs. Robinson has kindly handed me a pen which Messrs. Harmsworth produced under the name of "Answers" pen, and the feed bar now shown appears to be identical with that of this pen. It is interesting to note that the "Answers" pen was designed by Mr. Robinson in response to Messrs. Harmsworth's offer of a five-guinea prize for the best new invention, and he was successful in winning the prize.

Another pen is the invention of A. Theodorides in 1891 (17053). In this case the reservoir consists of an India rubber bag closed at one end, and having a rigid bent nozzle at the other, so adapted as to be in contact with the underside of the nib. In the outer case is an aperture through which the reservoir may be compressed by the finger when the nib requires a fresh supply of ink.

The feed bar shown in Fig. 151, T. W. Evans, 1892 (994), is of simple construction. *A* is the ordinary reservoir, having a point section, *B*, screwed into it. A nib, *C*, of ordinary form, is held in grooves in the point section and further kept in place by the plug, *E*. The solid plug, *D*, with its projecting beak or tongue, 1892 (23632), the ink reservoir consists of a rubber bag contained in the body of the pen, and attached at its mouth to a cylindrical piece, and at the other end to a revolving plug. The pen is filled by twisting the plug, and with it the rubber tube, so as to expel the air. On immersing the point in ink and reversing the twisting action, ink is drawn into the reservoir.

In Fig. 155 Leary & Callahan, 1893 (13092), *A*, is the usual ink reservoir, and *B* is the point section, having a nib holding section, *C*. The nib passes through the hole, and is attached to the spiral spring shown coiled within *B*, the end of which passes upward through an opening in the butt end of the nib, and then passes down its back, reaching to the slit. When the cap, *D*, is placed over the point, the nib impinges upon the swiveling part, *S*, and is forced backward against the pressure of the feed spring, which projects the nib into the forward position when the cap is again removed.

J. E. Chase, in 1893, patented a pen in which the nib is permanently attached to a rod by a rivet. The chief feature of this pen lies in the arrangement whereby the nib is made to recede when out of use.

The pen shown in Fig. 156, E. Reichmann, 1893 (20699), the inventor states, is for use with any form of steel nib. The reservoir, *A*, communicates with the flexible tube, *B*, which is pressed against the nib, *F*, by means of the spring, *C*. A wire, *D*, extends from the reservoir, *A*, through the tube, *B*, and terminates at *E*, and thus conveys ink to the nib, *F*.

The body, *A*, of the pen shown in Fig. 157, W. Post, 1894 (1039), contains a plunger or piston, *E*, attached to a rod or handle, *F*. The nib, *C*, fits into grooves in

the point section *B*. The body, or reservoir, *A*, is filled with ink by operating the plunger, *E*. The original pen, as described in the patent specification, shows the rod, *F*, as one piece, but the pen as now made has a telescopic rod, which reduces the length of the complete pen.

Fig. 158 shows a section through the ink feeding arrangement of C. E. Browning, 1894 (5256). The feed bar, *C*, is formed in one piece, and fits into the nozzle or point section, *B*. The nib, *N*, is held between the upper and lower tongues as shown, and projects backward into the ink chamber, *L*, which communicates with the ink reservoir by the side ducts. Grooves on the inner surfaces of the tongues communicate with the air passage, which runs centrally through the feed bar. This pen was introduced by Mr. Robinson as the "Regal."

In the feed bar shown in Fig. 159 of J. H. Stonehouse, patented in 1894 (5984), a central longitudinal groove extends along its upper surface next the nib. There are also one or more longitudinal grooves on either side for the passage of air. The pen is otherwise of ordinary construction.

The invention, D. Arriaza, 1894 (9220), illustrated in Fig. 160, relates to a pen in which a solution of solid ink is used to write with. The pellets of ink are stored in the receptacle, *B*. One or more of these pellets are placed in the reservoir, *A*, into which water is introduced. The internal reservoir, *G*, is of flexible rubber tubing, and by exerting a slight pressure on the stud, *F*, ink is forced along the tubes, *D*, and an ink conductor to the nib, *H*. When the pen is out of use the cap, *E*, is pushed backward so as to cover the opening in the feed tube, *D*.

(To be continued.)

MANUFACTURE OF GUN-COTTON.

For the production of a high-grade gun-cotton, it is very important that the cotton used should approach as near as possible to pure cellulose. The waste from cotton mills, thoroughly purified, is usually employed. After careful chemical examination has been made to ascertain its freedom from grease and other impurities, the cotton waste is picked over by hand to remove such impurities as wood, cardboard, string, etc. The cotton is then passed through the "teasing machine," which opens out all knots and lumps, thereby reducing it to a state more suitable for the acid treatment and exposing to view any foreign substances which may have escaped notice in the previous picking. The cotton is then dried. When perfectly dry, it is removed to air-tight iron cases, in which it is allowed to cool. The iron cases are taken to the dipping houses, and the cotton waste weighed into small portions which are then transferred as rapidly as possible to the mixed acids, allowed to remain a few minutes, then removed to the grating and the excess of acid squeezed out. The cotton now containing about ten times its weight of acid is placed in an earthenware pot and transferred to the steeping pits, where it is allowed to remain for twenty-four hours, a low temperature being maintained by a stream of cold water.

The cotton is now wholly converted into nitro-cellulose. The superfluous acid is next removed by a centrifugal extractor, after which the gun-cotton is taken out of the machine and immediately immersed in a large volume of water, and thoroughly washed until it shows no acid reaction. The moisture is then wrung out and the gun-cotton is conveyed by tramway to the boiling vats, where it undergoes several boilings by means of steam. When the "heat test" shows that a sufficient degree of stability has been obtained, the gun-cotton is removed to a beating engine, and reduced to a very fine state of division. When this process is completed the pulp is run by gravity along wooden shoots, provided with "grit traps" and electro-magnets, which catch any traces of sand, iron, etc., into large "poachers," in which the gun-cotton is continuously agitated, together with a large quantity of water. In this way it is thoroughly washed and a blend made of a large quantity of gun-cotton.

SOLUBLE GUN-COTTON.—Soluble gun-cotton is made on the same lines as above, except that greater attention has to be paid to the physical condition of the cotton used, and to the temperature and strength of acid mixture, etc.

The term "soluble" usually implies that the gun-cotton is dissolved by a mixture of ethyl-ether and ethyl-alcohol, two parts of the former to one of the latter being the proportions which yield the best solvent action. The classification of nitro-celluloses according to their solubility in ether-alcohol is misleading, except when the nitrogen contents are also quoted.

The number of solvents for gun-cotton which have at various times been proposed is very large. Among the more important may be mentioned the following: Alcohols (used chiefly in conjunction with other solvents) methyl, ethyl, propyl, and amyl, methyl-amyl ether, acetic ether, di-ethyl-ketone, methyl-ethyl ketone, amyl nitrate and acetate, nitro-benzole, nitro-toluol, nitrated oils, glacial acetic acid, camphor dissolved in alcohol, etc.

Some of the above may be called selective solvents, i.e., they dissolve one particular variety of gun-cotton better than others, so that solubility in any given solvent must not be used to indicate solubility in another. No nitro-cotton is entirely soluble in any solvent. The solution, after standing some time, always deposits a small amount of insoluble matter. Therefore, in making collodion solutions, care should be taken to place the bottles containing same in a place free from vibration and shock. After standing a few weeks the clear supernatant liquid may then be decanted off. On a larger scale collodion solutions are filtered under pressure through layers of tightly-packed cotton wool. The state of division is important. When the end in view is the production of a strong film or thread, it is advisable to use unpulped or only slightly pulped nitro-cellulose. In this condition it also dissolves more easily than the finely pulped material.

THE CHAMPAGNE INDUSTRY.

By CONSUL J. MARTIN MILLER.

DURING the past five years the consumption of champagne wine in the United States has increased over 35 per cent, or an average of about 7 per cent a year. The United States imported 1,235,880 bottles (quarts) more from the champagne district in 1905 than in 1900. Nothing but the best quality of champagne is exported to the United States, the high tariff operating to keep out the low grades. The United States is now consuming about 4,500,000 quart bottles per annum, and the amount in customs duties paid into the United States Treasury on account of this champagne, all of which is produced in what may be called the legal champagne district adjacent to Rheims, approximates $3,000,000 a year.

RELATIVE CONSUMPTION OF COUNTRIES.

The quantity of champagne in quart bottles* exported from Rheims to the United States annually during the past six years is as follows:

1900	3,287,628	1903	4,351,116
1901	3,700,524	1904	4,621,188
1902	4,132,716	1905	4,523,508

Great Britain imports almost double the amount represented in the figures for the United States, and drinks more champagne than any other nation. The United States ranks second and Russia third as champagne-drinking nations. Belgium is the greatest champagne-consuming nation in the world per capita, and the Scandinavian States are second in that respect, Norway leading Sweden or Denmark.

While France is recorded in the government reports as having consumed 9,335,412 quart bottles in 1903, 9,808,774 in 1904, and 8,864,947 in 1905, it must be understood that the greater part of this is the very cheap quality of wine made from the last pressings and the refuse of the champagne grapes that the first-class houses cannot use in their export trade. In the legitimate champagne trade it is estimated that less than one-fourth of these figures represent the champagne, in its true sense, that is consumed in France.

QUANTITIES EXPORTED.

The quantity of champagne sold from the Rheims district to all of the countries of the world, including France, for each year since 1900, inclusive, in quart bottles, is as follows:

1900	28,454,436	1903	31,859,158
1901	28,055,045	1904	30,893,655
1902	28,205,440	1905	28,710,799

Of all the champagne that is consumed in the world each year, the people of the United States drink approximately one-seventh. The champagne trade with Japan was about one-third more in 1905 than in 1904. Fifteen years ago the people of Japan used little or no champagne, and shipments were made only for the foreign residents. The exporters here point with pride to the fact that this denotes the progress of the "Yankees of the Far East" more than anything else.

China consumes very little champagne, and there is no record of any ever having been sent to Korea.

UNIFORM CUSTOMS DUTY.

The tariff on champagne is higher in Brazil ($1.44 a quart) than in any other country. Russia has the next highest tariff, the United States third, Peru fourth, and Germany fifth. On March 15, 1906, Russia reduced the tariff from 95 cents to 91 cents a quart. Italy has the lowest tariff. Greece is the only country in the world admitting champagne free. Great Britain has the very low tariff of 15 cents per quart. The following table gives the tariff per quart in the several countries, expressed in United States money:

Brazil	$1.44	Switzerland	$0.27
Russia	.91	Italy	.05
United States.....	.66 2-3	Spain	.24
Peru	.64	Japan	.06
Germany	.57	Austria-Hungary	.50
Mexico	.54	Portugal	.50
Cape Colony	†.52	Argentina	.32
Norway	.42	Chile	.38
Sweden	.39	Venezuela	.30
Denmark	.12	India	.14
Great Britain	.15	Federated Australia..	.53
Canada	.28	New Zealand	.37
Cuba	.17 1-2	Turkish Empire..	8 per ct.
Philippines	.66 2-3	Egypt	8 per ct.
Belgium	.10	China	5 per ct.
Holland	.06 1-2	Greece	Exempt

There is no government tax on champagne in France. Practically all the cities and large towns of the republic collect an "octroi" tax, however. This is 1 cent per bottle on all consumed in Rheims, and 6 cents at Marseilles and Nice. Paris abolished the tax a few years ago.

FEATURES OF THE TRADE.

Champagne is probably the only commercial commodity in the world that does not fluctuate from year to year, in either the wholesale or the retail price. It is the same this year as it was one year, five years, and ten years ago. The crop of champagne grapes may be much shorter in some years than others, but this does not affect the price of champagne in the least. Another peculiar feature of the champagne trade is that no matter what the tariff may be the retail price is practically the same the world over. A bottle of champagne at one of the leading hotels in Paris, where there is no duty, will cost about the same as at a similar place in New York or other American city; and the price is practically the same in London, Berlin, St. Petersburg, or Rome, the tariff apparently cutting no figure in establishing the price. Consumers in the United States should be thankful for the high tariff for the reason that it protects them against inferior qualities of sparkling wine.

INFERIOR GRADES.

The fourth and fifth pressings of the champagne grapes and the imperfect grapes that are carefully separated by hand from the choice ones are made into a cheap champagne of two or three different grades. Under the law, however, manufacturers may use the name "champagne" on this cheap wine, for it is made from champagne material. The great houses sell their last pressings and rejected materials to the smaller houses in the trade. This cheap champagne retails at the lower class of restaurants and public houses in Rheims, Paris, and other cities in France at 1 franc (20 cents) up to 2 or 3 francs per pint bottle. It will be seen that the cheapest grade sells for less at retail than the tariff imposed by the United States.

SPARKLE FROM NATURAL FERMENTATION.

It is safe to say that the sparkle in all the champagne shipped from here to the United States is from natural fermentation. Some of the cheaper sparkling wines, sometimes called "champagne," are artificially charged the same as the so-called champagne cider or soda water. This kind of sparkling wine has nothing in common with sparkling champagne except the bubbles. It is easy to detect the artificially prepared wine from the real by the fact that the effervescence of the former dies away almost immediately, while that of the latter remains for some length of time.

There seems to be an impression in the United States that considerable California still wine is sent to France and manufactured into champagne. Further on in this report I explain the law and why it is impossible to use for this purpose any material grown outside the champagne district. I am in receipt of a report from the French government giving the amount of California wine imported to France during the three years named, as follows: 1903, 63 hectoliters, or about 5,040 quarts; 1904, 151 hectoliters, or about 12,080 quarts; 1905, 48 hectoliters, or about 3,840 quarts. The fact that large quantities of cheap wine come to France from Tunis and Algeria has nothing to do with the champagne industry whatever. The French people are the greatest consumers of cheap wines in the world. It is used more generally than milk in the United States. Even the little children drink it. The public schools give it to the pupils. The servants insist upon the daily allowance for wine.

AGE DOES NOT IMPROVE.

Much of the champagne sent to the United States from here is three years old, but some of the choicest brands are five years old. Champagne, however, does not improve with age. Owing to the fact that it requires from three to five years to place champagne on the market after the grapes are pressed, it will be seen that vast capital is required by the great houses to keep the necessary stock on hand from which to meet current demands. The amount of stock constantly on hand in the cellars of the great houses of Rheims and vicinity amounts to about three times the amount that is sold every year. Should there be an entire failure of the grape crop in any one year there would be enough stock on hand to supply the trade without interruption.

The quantity of champagne stock on hand during the past six years was as follows, the figures representing quart bottles:

1900	99,019,659	1903	108,537,987
1901	100,641,967	1904	104,353,969
1902	113,898,775	1905	100,698,363

MANY MILES OF CAVES.

The great caves or cellars are miles in extent, dug out of the solid chalk, from 20 to 100 feet under ground, one under another, without any supports for the most part. It is under ground in these caves that the champagne is made, and where it is kept after the grapes are pressed, for from three to five years before it can be shipped to the dealers. The caves are completely lighted by electricity. Six of the large firms have caves that are 8 to 11 miles in extent each. These caves are in reality subterranean passages that almost rival the catacombs of Rome in extent. They are much greater in the number of miles than the subways or underground railways of New York and London combined. The champagne caves of Rheims and vicinity are estimated to be fully 150 miles in extent. The site on which Rheims is located, in the business portion at least, is completely honeycombed underneath with tunneled caves. The great caves of Pommery and some others are in the environs of Rheims.

Summer and winter they are kept at an even temperature—about 45 degrees Fahrenheit. One of the leading houses has short caves extending two or three hundred feet in both directions from the main tunnel, divided into geographical divisions representing the different nations of the world. These are subdivided

* Only so-called quart bottles are considered. Probably one-half of the 4,500,000 "quarts" consumed in the United States annually is in pint bottles. While the hotels and cafés quote prices for "quart" and "pint" bottles, the bottles do not contain full United States liquid quarts nor pints.

† Plus 10 per cent.

and named after the leading cities. The division representing the United States has its New York, Boston, Philadelphia, Washington, Chicago, New Orleans, San Francisco, etc., all indicated by large enamel letters. Here, in the same way, is London, Paris, Berlin, Rome, Yokohama, St. Petersburg, Melbourne, Calcutta, Buenos Aires, Mexico City, etc., including all the principal cities of the world. Each one of these spaces is piled high with pyramids of champagne in bottles.

WORKMEN AND THEIR METHODS.

The champagne workman is generally of a superior type to the factory hand, as much skilled labor is required. Wages run as high as 300 francs a month ($60), besides a bonus. In adopting the bonus system, to be paid only on condition of faithful and loyal service at the end of each year, the champagne manufacturers have effectively cured the strike evil. Cleanliness, order, and sobriety are strictly enforced on the part of the employes. No chemists or scientific men are necessary, no foreign matter being employed in making champagne. The "chef de caves" alone tastes and blends the wine in the requisite proportions. It requires about 4½ pounds of grapes to make one quart of champagne. The makers often pay as high as 1 franc a pound, while the ordinary table grapes sell in the market at less than one-fourth that price.

GROWTH AND GATHERING OF GRAPES.

The champagne grape is not used as table grapes. The latter are not grown here, but are shipped from other parts of France and from foreign countries. In fact it may be said that nothing but champagne grapes are grown in the champagne district. The champagne grape is small and exceptionally sweet, hence its special qualities for creating a natural, sparkling wine. It is not white, as many people think, but black. A white grape is used to a limited extent, however, by certain manufacturers.

Some of the great houses grow their own grapes in part, but most manufacturers buy them. The vines of champagne can be divided into three divisions: The Rheims Mountains, with the famous plantations of Verzy, Verzenay, Sillery, Mailly, Rilly, and others; Bouzy, Ambonnay, etc., and the famous hillsides of Avize, Le Mesnil, Oger, Grauves, and Cuis, all south of Epernay; lastly, the valley of the Marne, with Ay, Mareuil Champillon, Hautvillers, Piery, Dizy, Epernay, and Cumières. In these vineyards 25,000 vine dressers are employed. The cultivation of the champagne grape requires exceedingly refined processes, which to a great extent complicates and renders the work very expensive. The cultivation, including fertilizer, costs from $150 to $300 per acre each year.

PREPARATION FOR MARKET.

While the production of grapes varies somewhat from year to year, the soil of the Champagne district produces an average of nearly $20,000,000 worth each year. Everything for the production of the wine and placing it on the market, except the cork, is furnished here, and many of the grape growers as well as the wine makers, bottle manufacturers, and cork dealers have become very wealthy. The corks alone in the 4,500,000 bottles shipped to the United States each year cost fully $200,000, while the bottles cost at least $650,000. The champagne bottle of the present day in strength and endurance is the result of the development of many years. Owing to the loss of some of the elements in the glass a bottle cannot be used the second time for champagne. The manufacturers of the cheap and artificially charged wines use the second-hand bottles almost exclusively. The quart bottles, including the cork and fastener, cost from 18 to 22 cents each, and the pint bottles 12 to 16 cents each when bought in large quantities, as the great houses here must purchase them. The larger sized corks, which for champagne bottles must be the highest grade known, cost from 4 to 5 cents for each cork, or $40 to $50 per 1,000. The corks for pint bottles cost 3 to 3½ cents each. All corks for champagne bottles must be carefully selected. Every imperfect one is thrown aside for use outside the champagne trade. There are scores of cork experts employed by the large houses among the fifty cork manufacturers and dealers here, using material that comes from Spain and Portugal almost altogether.

PECULIARITIES OF THE SOIL.

The Champagne soil consists generally of a mixture of argillite, or clay, chalk, and sand. The thickness of the upper or top soil varies from two to three feet. The undersoil in certain parts is of a clayey and calcareous nature, mostly the latter, which is nearly pure chalk in many places. The latter has a depth of from 250 to 500 feet, and in some places much deeper. The vine adapts itself readily to the calcareous slopes, its roots absorb the fertilizing elements, which, owing to the permeableness of the soil, filter through the fissures of the chalk. On those slopes of a chalky composition the grapes grown produce a wine of a very superior character to that produced from grapes grown on the more clayey slopes. On the former maturity comes earlier; the upper soil, of very little depth, permeable, and very light, drys rapidly after a rain, the undersoil helping in that the water filters through very easily, permitting the sun's rays to heat the roots of the vines. The champagne vineyards are at the limit of the climate where it is possible to cultivate the vine in the open air.

CHAMPAGNE AND BURGUNDY.

Champagne wine derives its name from the ancient province of Champagne, now a part of the northeastern section of France. The plantation of the first champagne stocks is traced far back in history, certainly to the fifth century. One of the first, if not the original plantation, is near Rheims. The fame of champagne wine has caused it to be imitated by the use of grapes grown in other parts of France and in other countries. For a whole century Champagne and Burgundy had a demoralizing contest. At the end, by influential intercession, a peace was declared and signed in the following form by the representatives of both industries:

"That if Beaune inspires more love songs, Rheims inspires better music; that to become and remain joyful, a man requireth both these wines as much as he needs two legs."

THE INDUSTRY PROTECTED BY LAW.

It is forbidden by law to use the name "champagne" on any wine made from grapes grown in France or elsewhere outside the area prescribed in the immediate vicinity of Rheims, consisting of about 45,000 acres. A proposed law, more stringent than any heretofore enacted, has recently passed the Chamber of Deputies, and will undoubtedly pass the Senate and become a law at this session. This proposed law bounds more definitely than ever before the area within which grapes from which champagne may be made can be grown. The owner of the vineyards a half mile beyond the line cannot have his grapes manufactured into wine to be called "champagne." Under the law of March 21, 1884, many convictions of violators have been secured. Merchants using the materials coming from outside the district and selling the product as champagne have been heavily fined. A court action was brought in Rheims some time ago against a firm of wine merchants of Saumur. They were convicted of fraudulently using the name "champagne," fined 10,000 francs and costs, assessed for the payment of advertisements in twenty newspapers and the printing and the placing in conspicuous positions of 1,000 posters giving publicity to the fraud.

MANY EXPORTING HOUSES.

There are 52 firms exporting champagne from the Rheims district to the United States. Four of these do two-thirds of this business and nine of them nine-tenths of it, roughly speaking. There are altogether 247 champagne houses in the Rheims district. Some houses do not attempt to push their business in the United States, because they claim the methods of "drumming up trade" there require too much of an outlay. The methods of creating a champagne trade are entirely different in every country, it is said. For this reason some of the leading firms here devote their efforts to expanding their business in England, Russia, and other countries, simply accepting the orders that come to them from the United States.

THE ART OF CHAMPAGNE MAKING.

As a rule the public has a false and erroneous notion as to how "sparkling champagne" is prepared. Grapes are never trodden by the feet, but are crushed with machinery, by means of presses built on scientific principles. The "must" is at once separated from the stalk and skin which contains the coloring matter, and a liquid hardly tainted is obtained. After the first fermentation it becomes perfectly white. It is difficult to form an exact idea of the care which is exercised in gathering the grapes. The bunches are carefully detached one by one, without any pression, sorted according to their degree of ripeness, every berry generally well examined, the grapes being crushed every day without delay under the vine press. The liquid obtained from the press after three consecutive pressings gives the "brew." It is this wine which has the necessary qualities to make sparkling wine. Those obtained by subsequent pressings are called "Vins de suite" (after wines). Very inferior in quality, they can not be used for choice "champagne."

FERMENTATION.

As the "must" runs out of the press it is put into open tubs, where it is left to settle for twelve hours so as to allow the solid parts it contains to descend to the bottom of the tub. It is afterward drawn off into casks that have been scrupulously examined; this is called the "clearing out." Fermentation begins a few days later and changes the sweet liquid or "must" obtained by means of pressing into an alcoholic and acidulated liquid which takes the name of "wine." As soon as cold weather sets in the wine becomes perfectly clear, when it is again drawn off with the greatest care, so as to separate from the wine the dregs which have formed at the bottom of the barrel.

THE MIXING OR ASSEMBLING.

During the two months of January and February the merchant mixes in immense casks the wines of different vineyards which he has bought at the time of gathering. Experience has shown that in order to obtain wines uniting quality, "bouquet," vinosity, and daintiness the champagne maker must mix different wines which possess separately and individually each of those elements. It is in this mixing that the wine dealer shows his knowledge guided by experience, as he must base his judgment on the quality of the wine at each vintage and on the characteristics of each vineyard.

Generally wines put in reserve from previous years are mixed with those of the new vintage. Thanks to this proceeding, new wine is often improved, the type of former vintages is kept up, and the change is rendered imperceptible to the consumer.

THE BLENDING AND SPARKLE.

This name is given to the whole of the different wines. After they have been tasted by the head of the firm, their composition and importance are decided upon so as to form a homogeneous and harmonious "ensemble," in which "bouquets" have been combined, improved, and have completed one another.

As soon as spring sets in and the sap is in motion bottling is proceeded with. The bottles are rinsed with minute care, filled up, and hermetically corked by means of special tools. Then they are packed into immense stores. Here a few words of explanation are necessary. The first industrial attempts of drawing (bottling "sparkling champagne"), which were not very successful, date as far back as the year 1746. The breaking of bottles was considerable. The most experienced men of that time had no idea of the way in which sparkle was formed, and they contented themselves with tasting, in order to know whether the wine contained enough or too much sugar at the time of bottling. But in 1836 a distinguished chemist of Chalons-sur-Marne, Mr. François, succeeded, after numerous experiments, in determining the exact quantity of sugar which champagne must contain when being bottled, in order to give a fine sparkle. For this purpose he used the gleuco-œnometer (glass floater invented by Cadet Devaux) and took a given quantity of wine the alcohol of which had evaporated.

DETECTING PRESENCE OF SUGAR.

By means of the gleuco-œnometer the exact quantity of natural sugar contained in the wine is calculated before bottling. If this proportion is too small, the necessary quantity of pure candied cane sugar is added; then the wine is bottled. The raising of the temperature on one side and on the other the natural evolution of the ferments, which take place at the same time as vegetation begins in vines, cause an active fermentation, thus transforming naturally the original sugar, or that which has been added, into alcohol and carbonic-acid gas. In consequence of hermetic corking, it remains in the shape of a dissolution in the liquid and forms the sparkle. At that period the wine is said to be "raw." "Raw champagne" is good only when it comes from particularly good vintages with regard to quality and vinosity or, again, when it is kept for a good many years.

TWISTING AND DISGORGING.

The fermentation which has developed sparkle has given rise to dregs that must be removed. As soon therefore as the wine has remained long enough in the cellar to be almost matured the bottles are laid on their necks, viz., upside down in a desk or table pierced with holes and having an inclination of 60 degrees. Every day for six or eight weeks these bottles are gently shaken; that is, they are turned round with the hand by a sharp and quick circular movement. Gradually the dregs are displaced and come down on the cork. The dregs that have formed in the wine having accumulated on the cork, the liquor has become absolutely limpid. The workman takes the bottle with his left hand, keeping it inclined, cork downward, while with his right hand, by means of a hook, he cuts the wire which ties the cork. Drawn with pincers and blown out by the gas, the cork comes out with a bang, carrying with it the dregs. At that moment the man raises the bottle swiftly.

LIQUEURING AND DOSING.

Dosing is the most important performance after disgorging. By fermenting in the bottle the wine has lost almost the whole of its natural sugar and has thus become quite dry (brut). To remedy this a certain quantity of a liqueur, made solely of pure cane sugar of the very best quality, dissolved into exceptionally fine "champagne" of choicest growth, is added to each bottle. Such is the liqueur which is used to give sparkling "champagne" the degree of sweetness wanted, according to the different countries where it is to be sold, and where sweet or dry wine is preferred.

The champagne drinker without discrimination wants his champagne sweet, while the connoisseur wants it dry and in its most natural state, with possibly a little sugar. In former times the United States took its champagne considerably sweeter than now. Ten or a dozen years ago the wine sent from the Rheims district to the United States had to have as much as 8 to 9 per cent of sugar for the "Sec" or "Dry," while at present we will not have more than 3 per cent of sugar. Connoisseurs in France comment critically upon the American habit of putting ice into the glass when drinking champagne, which they claim should never be done.

England takes the driest champagne, while Russia takes the sweetest. Germany, Belgium, and the Scandinavian countries want it with a little less sugar than Russia. "Brut" is a natural champagne without any artificial sweetening. "Sec" and "Extra Sec" ("Dry" and "Extra Dry") have a small percentage of sugar.

CORKING AND PACKING.

The dosing done, the bottle is corked again with a new cork of a superior quality to prevent the loss of gas. The cork, which has been previously stamped by burning with the name of the firm, is made fast, sometimes with string, sometimes with wire, or with diverse systems, according to the merchant's taste.

When the bottle has its label, its silver paper, its brilliant or wax capsule covering, it has gone through all the different stages of dressing. According to habits and obligations imposed by different countries the bottle is wrapped up in paper, then in straw, and laid in cases or baskets of various sizes. The "champagne" bottle's resplendent toilet, when finished, has passed through the hands of forty-five workmen.

Crystalline Hair Oil.—800 parts of sesame oil, 100 of spermaceti, 50 of stearin, 20 of oil of bergamot, 20 of oil of geranium, 5 of oil of petitgrain, 4 of oil of cloves. With more spermaceti and stearin, this becomes a firm brilliantine usually colored green with chlorophyl.—Parfumeur.

MECHANICAL FEATURES OF SOME OF THE WINNING CARS IN THE AUTOMOBILE CLUB OF AMERICA'S TWO-GALLON FUEL CONTEST.*

As some of our readers are doubtless interested in the mechanical features of the cars which made the most striking performances in the fuel-economy test held on May 5, we give herewith a description of some of the carbureters and other mechanical features of these cars. The object of the test was to see how far each machine could be run on two gallons of gasoline. The winning car was determined by multiplying the total weight of the car (to which 800 pounds were added) by the number of miles run. Single-cylinder and double-cylinder cars were penalized by deducting 30 and 25 per cent of the weight, respectively. As a consequence they had no possible chance of making a good showing in the final score.

The winning car was a four-cylinder Franklin runabout, of the air-cooled type. The car which obtained second place was a large 24-horse-power, four-cylinder, air-cooled touring car, known as the Frayer-Miller; while the third car was a 20-horse-power Darracq, having a four-cylinder, water-cooled motor. Another French machine, having a similar type of motor of 24 horse-power, the Berliet, obtained fourth place, and a huge 50-horse-power, twenty-passenger 'bus was fifth. The sixth place would have gone to a single-cylinder, 10-horse-power, light Cadillac touring car, had it not been handicapped on account of its being a single-cylinder machine. As a result of this, the sixth position went to a four-cylinder, Franklin, light touring car, fitted with an identical engine of 12 horse-power to that used in the runabout, and a cut of which is shown herewith.

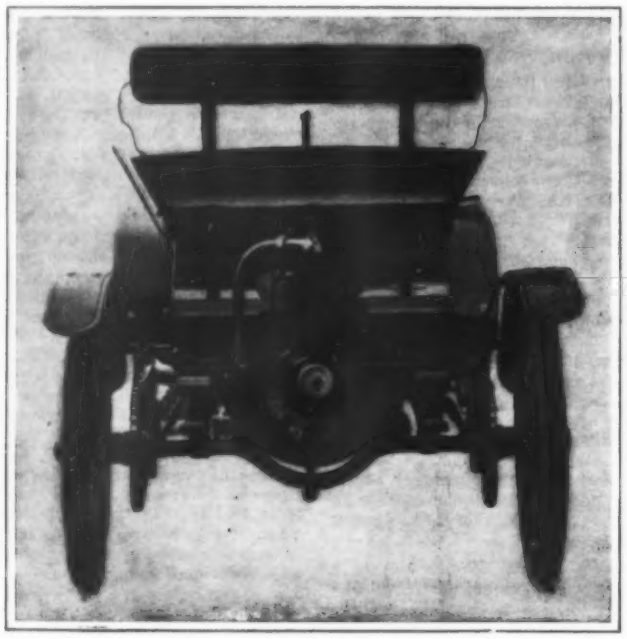
Besides having the various interesting features just mentioned, the Franklin engine is fitted with a rather novel carbureter, a cross section of which is here given. This carbureter has the usual air-tight, metallic float, *F*, placed in a suitable chamber, *A*, and arranged to close a ball-and-socket valve at the base of the stem, *S*, when the gasoline has obtained the level indicated by the line, *C D*. Suitable connecting passages, such as *E*, allow the gasoline to obtain a similar level in the spraying nozzle, *N*. The gasoline makes its entrance through the coupling, *K*, whence it passes upward through a conical strainer and a suitable connecting pipe, *P*, to the ball valve just mentioned. By unscrewing a cap, *K*, in the bottom of this pipe, *P'*, one can remove the coil spring, *H*, which holds the strainer in place. The strainer can thus be taken out and cleaned very readily. The mixing chamber of the carbureter is made conical in shape, and at its base is a disk, *M*, which throttles somewhat the supply of air entering through the pipe, *G*, and thus tends to make a strong suction past the spraying nozzle, *N*. The throttle valve, *T*, is of the ordinary butterfly valve type. When closed it completely shuts off the gas from the motor. The most notable feature of this carbureter is the needle valve, *B*, which controls the supply of gasoline that reaches the spraying nozzle, *N*. This valve is made of large size, and is connected through a flexible coupling, *J*, with a long rod, mounted just back of the dash, where it can easily be reached by the driver. The arrangement makes it possible to adjust the mixture to a nicety at all times. On account of this arrangement, and also from the fact that when the throttle is closed the gas is absolutely shut off, the driver can easily get the maximum efficiency from his engine. In making the record the driver would open his throttle about one-quarter (the spark being fully advanced), thus allowing his machine to speed up. He would then close the throttle abruptly, and allow the car to coast with the engine in gear. On long hills or even slight grades the engine was thrown out of gear and stopped. It could be readily started again by throwing in the clutch just before the car had come to rest.

As the record of 87 miles was made under poor weather conditions, and part of the way on muddy roads, our Editor was of the opinion that this distance could be considerably increased. A subsequent test held by the Automobile Club officials resulted in the covering of 95 miles on two gallons of gasoline, while the car which was second in the first test, with a mileage of 47.9, succeeded in making 59.8 miles under more favorable conditions. The weight of the Franklin car was 1,500 pounds with passengers and all supplies included. The Frayer-Miller weighed 3,270 pounds, and the Darracq 3,110 pounds. The cost per ton-mile of gasoline for the first six cars was as follows: 0.613, 0.517, 0.553, 0.559, 0.500, 0.640 of a cent.

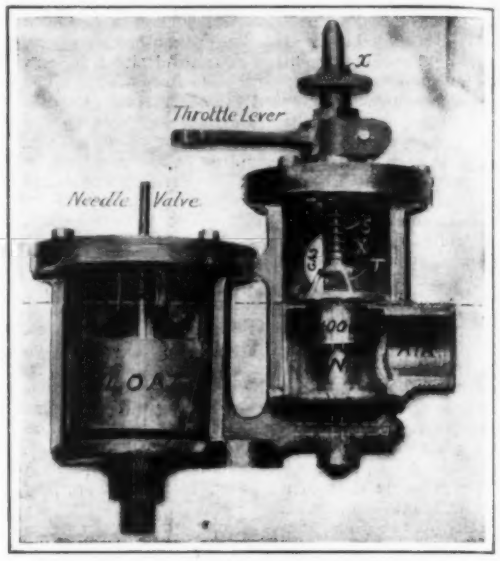
The machine which traveled the greatest distance was an Orient buckboard. This machine made 98.8 miles, while another one of the same make covered 93.8 miles. Two Compound machines, weighing 2,635 and 2,610 pounds respectively, covered 43.5 and 43.4 miles. The machine which covered the next greatest distance after the winner was a light, single-cylinder Covert machine of 6½ horse-power and 1,220 pounds weight. This little machine ran 73.75 miles, despite the fact that it made several detours from getting off the road. The leading features of the Frayer-Miller and Orient buckboard machines are described below, as well as the engine and carbureter of the Franklin car. The test as a whole demonstrated that American machines are second to none as regards fuel consumption.

The Frayer-Miller car has a novel air-cooled system consisting of air jackets and a powerful blower. The car demonstrated well the feasibility of cooling a four-cylinder touring-car motor of 24 horse-power entirely by air. The Frayer-Miller engine uses very little oil. It is fitted with a mechanical lubricator. The engine shown in the accompanying illustration is a positively-cooled waterless four-cylinder engine of 4 1/16 bore by 5⅛-inch stroke. The cylinders are cast with pin-like projections around the heads, which aid in radiating heat. The valves are attached to each side of a cylinder head, and the whole cylinder is jacketed with an air jacket of aluminium. Air is blown by a powerful blower, gear-driven from the crankshaft in front of the motor. A pressure of about 2 ounces is produced in the large pipe running over all the cylinders, and this pressure is sufficient to force the cooling air down through the jackets and pins which project from the cylinder walls. So efficient is the cooling, that a relatively high compression can be used without danger of premature explosions from heat. This system is one of the few in which the motor is positively cooled at all speeds.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



REAR VIEW OF LIGHT BUCKBOARD, SHOWING DOUBLE CHAIN DRIVE FROM COUNTERSHAFT.

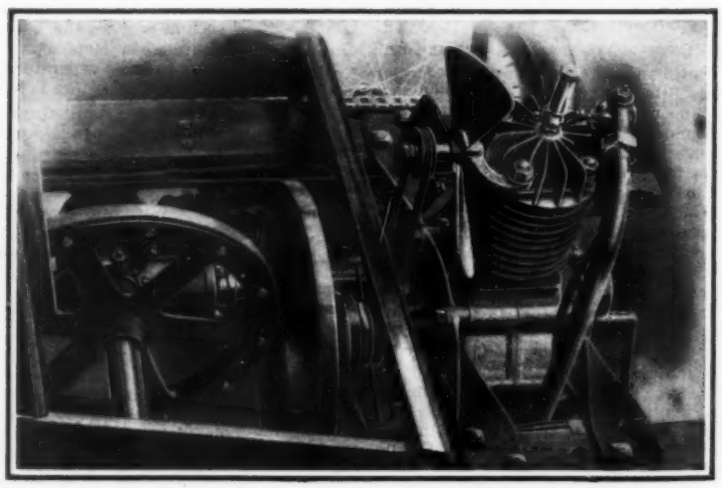


AUTOMATIC FLOAT-FEED CARBURETER OF BUCKBOARD.

N, Spraying nozzle. *T*, Auxiliary air valve. *S*, Adjustable spring of air valve. *x*, Thumb screw for adjusting tension of *S*. *X*, Throttle valve.

THE 15-HORSE-POWER COMPOUND CAR.

This car has two 4 x 4 high-pressure cylinders and a third 7 x 4 low-pressure cylinder between them.



THE FRICTION DISK DRIVE EMPLOYED ON THE BUCKBOARD RUNABOUT.

This form of drive has also been used successfully on heavy commercial vehicles and touring cars.

MECHANICAL FEATURES OF SOME OF THE WINNING CARS IN THE AUTOMOBILE CLUB OF AMERICA'S TWO-GALLON FUEL CONTEST.

The two 4-wheeled automobiles which went the farthest were two small Orient buckboards. These weighed 930 and 920 pounds, and covered 98.8 and 93.8 miles respectively. On these little cars, the single-cylinder air-cooled motor of 4 horse-power is placed at the rear end of the car, being mounted on the frame of the body directly over the rear axle. The motor shaft is placed lengthwise of the car. On its forward end is a large friction disk. A countershaft placed in front of the disk carries a friction pulley at right angles to the disk. By sliding the pulley across the face of the disk any number of different speeds can be obtained. The reverse is obtained by sliding the pulley over to the opposite side of the disk, and any speed from the slowest to the highest can also be had in this direction. The friction disk arrangement is shown in the cut opposite. The countershaft drives the rear wheels by chains, as shown in the cut. A fan is placed in front of the motor. The valves, commutators, and spark plug are readily got at from behind. The carbureter used is described as follows:

The chamber on the left contains the float, which rises as the gasoline enters through the pipe in the horizontal pipe, passes up through the hood around the spraying nozzle and out through the hole at the back, which is shown in the cut half closed by the throttle. The throttle lever is seen on top. The horizontal disk above the hood and spraying nozzle has a hole in the center and a ring of smaller holes just within its periphery. It is integral with the spider, *T*, and is held to its seat by the coiled spring shown. When the suction of the motor increases and more air is required, this valve is raised and an additional supply of air beyond what normally passes through the holes, is drawn in. The tension on the spring may be adjusted by the milled nut, *x*, on the top of the carbureter.

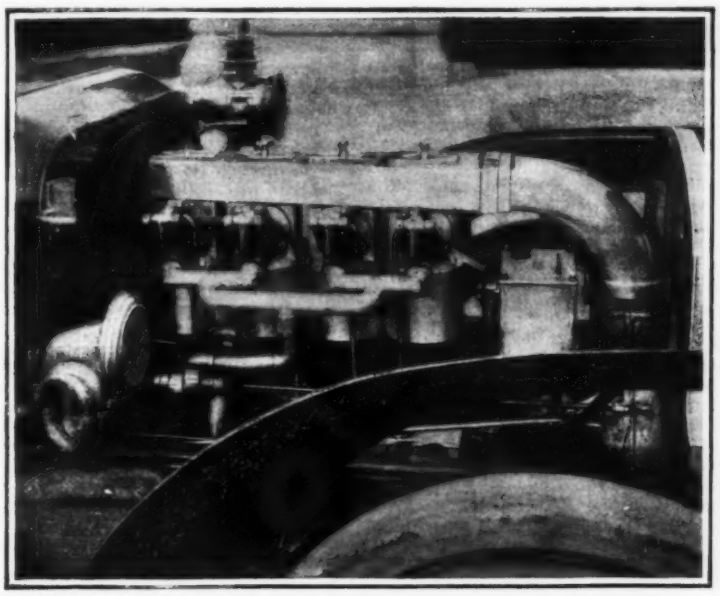
The air-cooled Franklin motor is a 3¼ x 3¼ flanged cylinder engine, with both exhaust and inlet valves in the heads of the cylinders, and with an auxiliary exhaust port at their base, so that when the piston uncovers this port, a great part of the exhaust gas blows out through a check valve before the piston exhausts the remainder upon its upward stroke. This special feature, together with a good-sized belt-driven fan at the front of the motor, keeps this motor sufficiently cool bureter supplies all four cylinders with gas. The engine is connected to a three-speed sliding gear transmission fitted with roller bearings throughout and having gears of nickel steel. A universally-jointed propeller shaft extends to the rear axle, which is of the live type, mounted on roller bearings and revolved by bevel gears. The bevel gears are held in absolute alignment, and the bevel pinion shaft is supported at each end by bearings.

We print below the list of cars in the order in which they scored. The table gives the horse-power and weight of the cars loaded, the distance they traveled on two gallons of gasoline, the score compiled from the formula (total weight + 800 × distance traveled, the weight of single-cylinder machines being taken as 70 per cent of the actual weight and that of double-cylinder cars as 75 per cent), and the actual pound-miles made.

TABLE SHOWING PERFORMANCES OF CARS IN TWO-GALLON FUEL CONTEST.

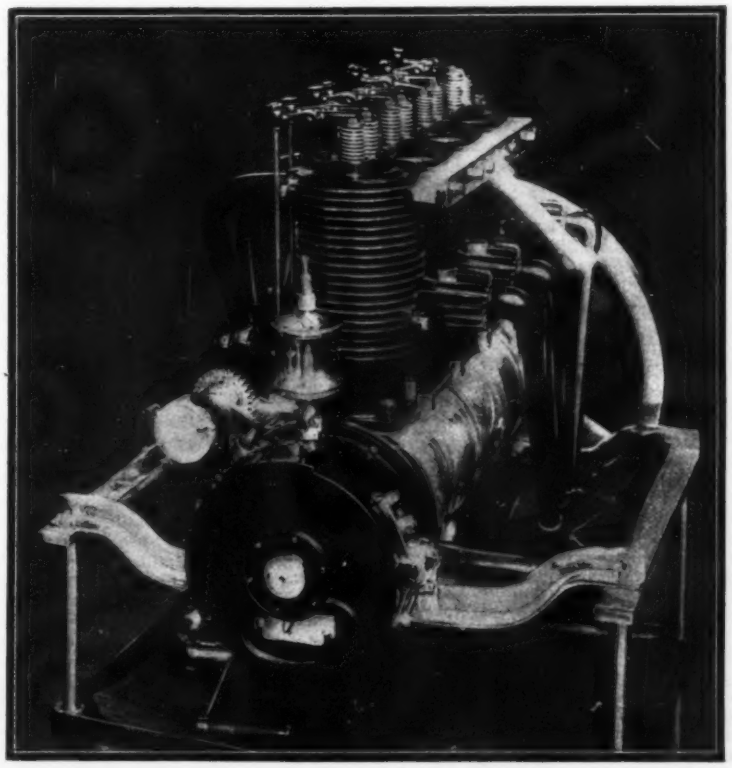
Make.	Cylinders.	Horse Power	Passengers.	Weight.	Miles.	Score.	Actual Lb.-Miles.
1. Franklin	4	12	2	1500	87.00	200,100	130,500
2. Frayer-Miller	4	24	5	3270	47.9	194,953	156,633
3. Darracq	4	20	5	3110	46.44	181,580	144,428
4. Berliet	4	24	5	3660	39.10	174,386	143,106
5. Mack	4	50	20	9625	17.13	173,441	159,737
6. Franklin	4	12	4	2140	58.40	171,696	124,976
7. Queen	4	28	4	3180	41.40	163,944	130,824
8. Stoddard Dayton	4	30	5	3300	40.83	163,320	130,656
9. Lozier	4	40	6	4490	30.28	160 181	135,957
10. Renault brougham	4	14	3	3400	36.61	153,762	124,474
11. Darracq	4	32	4	3600	34 62	152,328	124,632
12. Compound	3	16	5	2635	43.50	149,422	114,622
13. Renault landauiet	4	10	4	3240	36.83	148,796	119,329
14. Packard	4	24	6	4110	30 25	148,527	124,327
15. Napier	4	18	2	2220	49.10	148,282	109,002
16. Compound	3	16	5	2610	43.40	147,994	113,374
17. Franklin	4	12	4	2240	48.32	146,892	108 236
18. American Mercedes	4	45	7	4440	27.77	145,556	123,334
19. Orient Buckboard	1	4	2	930	98.80	143,358	91,884
20. Frayer-Miller	6	36	7	4055	29.40	142,737	119,217
21. Packard	4	24	5	3890	30.56	142 409	117,901
22. Packard	4	24	4	3560	32.51	142,393	116,385
23. Franklin	4	20	5	2720	39.86	140,307	108,419
24. La Comete	4	36	6	4540	26.00	138,840	118,040
25. Locomobile	4	35	7	4640	25.41	138,280	117,902
26. Aero Car	4	24	5	3250	33.79	136,849	109,817
27. Orient Buckboard	1	4	2	920	93.80	135,447	86,296
28. Duryea	3	15	4	2030	53.50	135,114	106 605
29. Simplex	4	30	5	3900	28.64	134,608	111 606
30 Franklin	4	12	5	2220	44.50	134,200	98,790
31. Franklin	4	12	4	2170	45.00	133,660	97,650
32. Cadillac	1	10	4	2250	55.50	131,812	124 875
33. Franklin	6	30	5	3280	31.84	128,315	102,848
34. Martini	4	40	4	3970	23.88	128,217	106,713
35. Fiat	4	20	3	3340	30.43	125,960	101,636
36. Compound	3	16	4	2260	39 49	124,788	93,196
37. Columbia	4	45	5	4220	24.30	121,986	102,546
38. Rochet-Schneider	4	35	5	4000	25.34	121,632	101,360
39. Renault brougham	4	14	4	3180	30.55	121,589	97,149
40. Covert	1	6	2	1220	73.25	121,155	89,365
41. Mercedes	4	40	3	3410	28.63	120,532	97,628
42. Elmore	4	35	5	3380	28.20	117,876	95,316
43. Darracq	4	35	3	3560	26.81	116,891	95,443
44. Winton	4	20	5	3080	28.50	110,580	87,780
45. Oldsmobile	1	7	2	1660	56.30	110,460	93,458
46. Hotchkiss	4	35	5	3900	23.10	108 570	90,000
47. White	2	20	5	3380	25.96	108,512	87,744
48. Maxwell	2	16	5	2640	36.01	100,107	95,086
49. Cadillac	1	10	2	1780	48.60	99,435	86,508
50. Columbia	4	28	4	2920	26.28	97,761	76,137
51. White	2	18	4	3225	40.25	95,835	76,787
52. Simplex	4	30	2	3110	24.13	94,348	75,044
53. Bliss	4	40	5	4140	19.01	93,909	78,701
54. White	2	15	5	3380	22,51	93,868	75,858
55. Wayne	4	24	5	3000	22.00	83,600	66.000
56. Mors	4	40	5	4490	15.72	83,158	70,852
57. Oldsmobile	1	4	2	1330	45.50	78,760	60,515
58. Panhard*	4	12	4	3190	19.53	77,924	62,300
59. Northern	2	18	3	2760	25 87	74,246	71,401
60. Buick	2	22	2	2280	28.78	72,237	65,618

*This machine did not finish owing to a breakdown. It could have gone farther.



THE 24-HORSE-POWER AIR-COOLED FRAYER-MILLER ENGINE.

This engine has a blower in front for supplying a powerful air current to the aluminium air jackets. The cylinders are 4⅛ x 5½ inches.



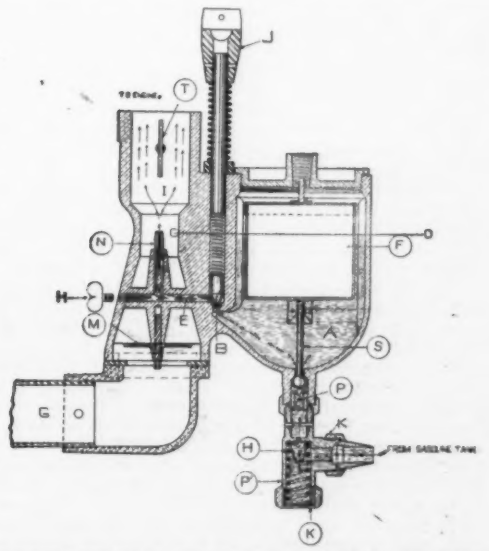
12-HORSE-POWER FRANKLIN AIR-COOLED MOTOR FITTED WITH AUXILIARY EXHAUST PIPES, WHICH CAUSE A 20 PER CENT INCREASE IN POWER.

The cylinders of this motor are 3¼ x 3¼, while those of the 20 and 30-horse-power engines are 4 x 4. The planetary transmission, from which a chain extends to the rear axle, is shown on end of motor.

MECHANICAL FEATURES OF SOME OF THE WINNING CARS IN THE AUTOMOBILE CLUB OF AMERICA'S TWO-GALLON FUEL CONTEST.

STORED LIGHT.

THE attention of the public has lately been called to new sources of light, and to certain substances possessing the strange property of emitting "obscure light." A similar fact is of interest to photographers; cellulose matter, paper, and fabrics of various kinds undergo an invisible modification through the influence of solar rays; they themselves become sources of light and act as if they were really such. This phenomenon can be demonstrated by a simple experiment.



LONGITUDINAL VERTICAL SECTION OF THE FRANKLIN CARBURETER.

If a sheet of white paper is exposed to daylight under a negative in a printing frame and then this is put in contact for several hours with a sheet of sensitive chloride of silver paper, in a dark room, the latter sheet will exhibit the image of the negative.

Of course, the isolated paper may be brought in contact with gelatino-bromide of silver paper followed by development.

Better still, to demonstrate that the accumulated absorbed light is a verity, the experiment may be rendered more complex. When the paper is taken off the negative in the dark room and placed in contact with another sheet of white paper for twenty-four hours, and this second sheet is applied to a sensitized paper, there is still an image, but feebler than that which the first sheet would give. Stranger still, the reproduction of the image takes place even when the sheet isolated under the negative and the sensitive sheet are put opposite and parallel to each other at a distance of one centimeter. In order to have these experiments succeed, it is indispensable to employ paper that has long been kept in the dark.

M. Laborde has proved that the presence of the isolated paper is not absolutely indispensable to modify a sensitive paper.

By putting an ordinary white paper which has been exposed previously to the solar rays, into a tin tube for four hours and then withdrawing and replacing it with a sensitive paper, the latter is modified in the same way as the two sheets which had been brought into contact with each other.

Niepce de Saint Victor kept for several months sheets of ordinary paper, which he had first isolated, in a tin tube hermetically sealed; then he opened the tube, and holding a sensitive paper to the opening, obtained a black disk of reduced silver. This phenomenon remains to be accounted for. The hypothesis which seems nearest to the truth, and which assumes that the paper undergoes a process of phosphorescence, is destroyed by the fact that a glass plate interposed between the isolated and the sensitive papers prevents the modification of the latter, and we have seen that the presence of the isolated paper is not indispensable.

These observations show that photographers ought to be careful: (1) Not to separate printed negatives or negatives of which the development is deferred, by sheets of white or of black paper which have been constantly exposed to the light; (2) not to pile up the negatives to be developed with gelatine against gelatine, but with the glass against the gelatine; (3) not to let other solar rays penetrate the photographic apparatus except those which pass through the "objective" during the pose. Negatives partly or entirely fogged or defaced with spots and streaks are the result of carelessness in surrounding the negatives with newspapers or separating them with paper taken at random. We should remember that "black light" (black because our optic nerves are not sensitive enough to be affected) may be an enemy to photographic preparation. Gelatine-silver-bromide sees better than our eyes.—Translated from the Photo Gazette of Paris.

MARVELS OF MINUTE WRITING.

MINUTE works of art have always excited the curiosity and commanded the admiration of the average man. Consequently Cicero thought it worth while to record that the entire Iliad of Homer had been written upon parchment in characters so fine that the copy could be inclosed in a nutshell. This has always been regarded as a marvelous feat.

There is in the French Cabinet of Medals a seal, said to have belonged to Michael Angelo, the fabrication of which must date from a very remote epoch, and upon which fifteen figures have been engraved in a circular space of fourteen millimeters (0.55 inch) in diameter. These figures cannot be distinguished by the naked eye.

The Ten Commandments have been engraved in characters so fine that they could be stamped upon one side of a nickel five-cent piece, and on several occasions the Lord's Prayer has been engraved on one side of a gold dollar, the diameter of which is six-tenths of an inch.

In the Harleian manuscript, 530, there is an account of a "rare piece of work, brought to pass by Peter Bales, an Englishman, and a clerk of the chancery." Disraeli tells us that it was "the whole Bible in an English walnut, no bigger than a hen's egg. The nut holdeth the book: there are as many leaves in his little book as in the great Bible, and he hath written as much in one of his little leaves as a great leaf of the Bible."

The specimens of fine writing thus far described have been produced directly by the hand under the guidance either of a magnifier or the simple sense of motion. Just how far it would be possible to go by these means has never been determined, but those who have examined the specimens of selected diatoms and insect scales in which objects that are utterly invisible to the naked eye are arranged with great accuracy so as to form the most beautiful figures, can readily believe that a combination of microscopical dexterity and skill in penmanship might easily go far beyond anything that has yet been accomplished in this direction, either in ancient or modern times.

But by means of a very simple mechanical arrangement, the motion of the hand in every direction may be accurately reduced or enlarged to almost any extent, and it thus becomes possible to form letters which are inconceivably small. The instrument by which this is accomplished is known as a pantagraph, and it has, within a few years, become quite popular as a means of reducing or enlarging pictures of various kinds, including crayon reproductions of photographs. Its construction and use are, therefore, very generally understood. It was by means of a very finely-made instrument embodying the principles of the pantagraph that the extraordinarily fine work which we are about to describe was accomplished.

On April 25, 1855, Mr. Farrants read before the Microscopical Society of London a full account of a machine constructed by Mr. N. Peters, a London banker. With this machine the inventor had written the Lord's Prayer (in the ordinary writing character, without abbreviation or contraction of any kind), in a space not exceeding the one hundred and fifty-thousandth of a square inch. Seven years later, Mr. Farrants, as president of the Microscopical Society, described further improvements in the machine of Mr. Peters, and made the following statement: "The Lord's Prayer has been written and may be read in the one-three hundred and fifty-six thousandth of an English square inch. The measurements of one of these specimens was verified by Dr. Bowerbank, with a difference of not more than one five-millionth of an inch, and that difference, small as it is, arose from his not including the prolongation of the letter *f* in the sentence 'deliver us from evil'; so he made the area occupied by the writing less than that stated above."

Some idea of the minuteness of the characters in these specimens may be obtained from the statement that the whole Bible and Testament, in writing of the same size, might be placed twenty-two times on the surface of a square inch. The grounds for this startling assertion are as follows: "The Bible and Testament together, in the English language, are said to contain 3,566,480 letters. The number of letters in the Lord's Prayer, as written, ending in the sentence, 'deliver us from evil,' is 223, whence, as 3,566,480 divided by 223 is equal to 15,922, it appears that the Bible and Testament together contain the same number of letters as the Lord's Prayer written 16,000 times; if then the prayer were written in 1-16,000 of an inch, the Bible and Testament in writing of the same size would be contained by one square inch; but as 1-356,000th of an inch is one twenty-second part of 1-15,922th of an inch, it follows that the Bible and Testament, in writing of that size, would occupy less space than one twenty-second part of a square inch."

And yet minute as are the letters written by this machine, they are characterized by a clearness and precision of form which proves that the moving parts of the machine, while possessing the utmost delicacy of freedom, are absolutely destitute of shake, a union of requisites very difficult of fulfillment, but quite indispensable to the satisfactory performance of the apparatus.

There was another micrographer, Mr. William Webb, of London, who succeeded in producing some marvelous results. Epigrams and also the Lord's Prayer written in the one-thousandth part of a square inch have been freely distributed. Mr. Webb also produced a few copies of the second chapter of the Gospel according to St. John, written on the scale of the whole Bible, to a little more than three-quarters of a square inch, and of the Lord's Prayer written on the scale of the whole Bible eight times on a square inch. Mr. Webb died about fifteen years ago, and he has had no successor in the art. Specimens of his work are quite scarce, most of them having found their way into the cabinets of public museums and societies, who are unwilling to part with them. The late Dr. Woodward, director of the Army Medical Museum, Washington, D. C., procured two of them on special order for the museum. Mr. Webb had brought out these fine writings as tests for certain qualities of the microscope, and it was to "serve as tests for high-power objectives" that Dr. Woodward procured the specimens now in the microscopical department of the museum.—From Phin's "Seven Follies of Science." D. Van Nostrand Co., Publishers.

WHAT IS AN ALLOY?

Prof. A. HUMBOLDT SEXTON.

WHEN two or more metals are melted together they, as a rule, remain intimately mixed, showing little tendency to separate according to their density, or as it may be otherwise expressed, they remain in solution one in the other while they are in the liquid condition. When the mass solidifies this state of uniform distribution or mixture may continue, or it may be broken up. In the former case the solidified mass will contain the constituent metals in a condition of more or less uniform diffusion, and such a mass is called an alloy. In the latter case the metals will separate according to their specific gravity, the heavier metal going to the bottom and the lighter rising to the top, such separation being as a rule the more complete the slower the solidification. The separated metals in this case are rarely if ever pure, but each retains a small quantity of the other, and strictly speaking both are therefore alloys. In practice, however, the term alloy is restricted to those cases in which neither of the metals is present in very small proportion; the other cases being simply considered as metals containing an impurity.

An alloy is, then, an intimate mixture of two or more metals, and the term mixed metals has sometimes been used in place of alloys. This is, however, very misleading, as the alloys are much more than mere mixtures, and mixtures of metals may exist which are not alloys.

If lead and copper be melted together, and the mixture be slowly cooled, the metals will separate. If, however, the mixture be quickly cooled separation cannot take place and the metals will remain mechanically mixed the one with the other, they not having had time to separate into distinct layers, but the mass will consist of intermixed particles of the two metals, and if it be heated up to the melting point of lead this metal may be, to a large extent, melted out. This would be a case of a mixture of metals, but not of an alloy. In an alloy the mixture must be of such a character that the constituent metals lose their individuality, and become blended into a new substance which has properties, to some extent at least, unlike that of its constituents.

As a rule, substances which are not elements are divided into the two classes, chemical compounds and mechanical mixtures, but the metallic alloy cannot be made to fit exactly into either group. In a mere mixture the particles, however small and however intimately they may be mixed, always retain their individuality, and the properties of the mixture are always a mean of that of its constituents. If the constituents be black and white the mixture will be gray, if red and white, a paler shade of red, and so on through all the other properties. This, as is well known, is not the case with alloys. Brass containing, say, 50 per cent of copper and 50 per cent of zinc, is yellow, and this yellow color is certainly not a mean between the red of the copper and the bluish white of the zinc; nor is its specific gravity, or indeed any other property, a mean between those of its constituents. The only point in which alloys always resemble their constituents is in the fact that they are distinctly metallic.

Alloys, then, are not mechanical mixtures.

A chemical compound contains the elements in fixed proportions, these being always simple multiples of the atomic weights, and some of the physical properties follow from the molecular weight of the compound. This is not the case with alloys. As a rule, the metals are not present in any simple atomic proportion, and further the proportions can be varied within, often, wide limits without producing any serious change in the properties of the alloy.

The metals do not show any strong chemical affinity one for another, but there is no doubt that in some cases definite chemical compounds of the metals do exist, but in no case do they form alloys of any industrial importance.

Solutions.—There is still another form in which substances can exist which, while not a mere mechanical mixture, is something less than chemical combination. If salt or any other soluble substance be stirred up with water it disappears, or dissolves in the water, and the result is a solution of the salt. This solution has some of the properties of the salt; it has, for instance, a salt taste, yet its properties cannot be said to be a mean between those of water and salt. The salt dissolves without increasing the volume of the solution, so that the solution is denser than the mean between salt and water. The addition of the salt also lowers the freezing point of the water, so that the freezing point of the solution, instead of being a mean between that of water and salt, is lower than that of either, and by the addition of proper proportions of salt may be reduced to about —22.5 deg. C.

The essential character of a solution is that the constituents are so intimately mixed, probably the mixture being actually molecular, that they cannot be separated or detected by mechanical means, while at the same time they have not entered into true chemical combination.

As a rule, when a solution is solidified, the constituents separate one from another to a larger or smaller extent, but this is not always the case. We can imagine a solution to become solid, and the result would then be a solid solution in which the bodies would still be so intimately mixed that no mechanical separation would be possible, and in which the properties would not be a mean of those of its constituents, but in which these constituents would not be present in the definite proportions required for a chemical compound.

True alloys are never mere mechanical mixtures of metals. Though in some cases the metals do combine, yielding definite chemical compounds, none of these compounds are of any use in the arts. Alloys are very frequently solid solutions of one metal in another, or of a chemical compound of the metals in the metal which is in excess. Many consist of mixtures of such solutions with definite substances that have crystallized out during cooling, so that the actual composition and structure may vary very widely; and each alloy, or rather group of alloys, must be studied separately, as it is impossible to lay down any except the most general rules.—Mechanical Engineer.

Writing and Figures on Photographic Negatives.—To make writing and figures on photographic negatives, which can be printed with them, the following method is given by a photographic journal. Two solutions are to be prepared, as follows: 1. Sugar, 15 parts by weight; glycerin, 5 parts by weight; water, 60 parts by weight. 2. Mercuric chloride, 5 parts by weight; mercuric nitrate, 10 parts by weight; alcohol, 60 parts by weight. For use, mix equal parts of the solutions, and write what is desired with a quill pen on ordinary writing paper, transferring it to the negative by pressing the paper upon the gelatin film. The writing will be reversed on the negative, but will appear correctly when printed.—Gut Licht.

THE TELEPHONE SYSTEM OF THE FUTURE—THE SEMI-AUTOMATIC.*

By LE ROY W. STANTON.

THREE distinct types of telephone equipment have been developed—the magneto or local battery, the common battery or lamp signal, and the automatic system. The first two may be further subdivided into the transfer and multiple systems. At the present time two telephone systems are being developed which are the outgrowth of the systems mentioned above. One of these may be called the transfer or trunking system. It is applicable only to large cities. The other, called the semi-automatic, is applicable not only to the large cities, but to smaller cities and towns.

The trunking or transfer system is a development of the original transfer system. It is due to an effort to meet the increasing demands of the rapidly-growing telephone systems. In the early days of telephony, when there were but few subscribers, but more than one operator could take care of, the calls were transferred from one operator to another by what was known as a transfer. Later the multiple switchboard was devised, thus eliminating the transfer. Now the still greater increase in number of telephones has carried the capacity beyond that of the multiple switchboard, thus making necessary the establishment of branch exchanges with trunk connections. This growth has increased to such an extent that in some of the larger cities a score of branch exchanges are required. When a development so great as this has taken place, a large percentage of the originating calls in any one of the exchanges is for a subscriber in some exchange other than the one originating it. For this reason the subscriber's multiple, which is placed within reach of the A or originating operators, is used but very little, often ninety per cent of the calls being trunked to other exchanges. In such a case an expensive part of the central office equipment has an efficiency of only ten per cent and is not fulfilling the requirement for which it was intended, namely, that of eliminating the extra operator in making a connection between two subscribers.

The present tendency in large cities is to eliminate the A subscriber's multiple and treat every call as a trunked call. While this system is gaining favor over exchanges with the multiple system as used to-day in leading cities, it is far from being as economical in first cost or in operating expenses as a system which may be called the semi-automatic. Such a system, generally speaking, embodies the valuable principles of both the manual and the automatic. It eliminates a good number of the operators who are found in the manual system, and avoids the complicated mechanism found in the automatic system. It utilizes the telephones at the present time employed in the manual common battery system. Its operation is briefly this: a subscriber, upon lifting his receiver from the hook, operates in the main office a line relay similar to that used in the modern lamp signal board, but this, instead of lighting a line lamp, energizes a simple selector-switch which selects an operator who is not busy and, in turn, selects a connecting cord which is not busy, and lights the lamp associated with this cord. The current lighting this lamp passes through a low-wound relay, which connects the operator with the subscriber. Upon receiving the number of the instrument wanted, the operator inserts the plug in the multiple and rings. Upon inserting the plug in the jack, the cord-lamp is automatically extinguished and the operator's listening set is disconnected at the same time, leaving the two subscribers to converse in privacy. This action also leaves the operator free to receive another call. When the subscribers finish their conversation and restore their receivers to the switch hooks, the lines are automatically disconnected. This leaves the line free to receive other calls or gives the subscribers opportunity to call again immediately. It leaves the plug in the jack until the operator removes it, but the automatic disconnecting of the two subscribers leaves this cord and plug dead. The busy test is taken off the multiple jack, and the disconnecting lamp signal corresponding to the cord used is lighted, thus notifying the operator to take down the connection.

With such a system an operator would be constantly busy, and since she would never be overloaded nor ever idle, the service would be prompt and uniform. She can receive only one call at a time, due to the automatic distribution of the calls to any one operator. The subscriber, upon lifting the receiver from the hook, automatically is put in talking connection with the operator, who gives the number desired without waiting for a request. The operator repeats the number and glances at the keyboard, noting the lighted lamp which indicates the cord to be used in making the connection. Owing to the fact that she would not be required to use an answering cord, listening key, or ask for a number—operations which take up the greater part of her time—and owing to the automatic selections, she would probably answer three times the number of calls usually attended to by an operator under the present system in the same time. For night service, Sunday service or at other times when the load is light, the number of operators can be reduced. Owing to the fact that the first few operators receive all the calls, the last positions are only brought into service during the rush hours.

The system just outlined is especially applicable to towns and small cities. By means of a slight increase in the equipment an additional advantage is gained through automatic trunking and branch exchanges. In such a system automatic trunking equipment is used in the branch exchanges. A subscriber, upon lifting the receiver from the hook, operates a simple line relay in the branch office, which, in turn, operates a selector, which selects a non-busy trunk to the main office, whereupon the operator would be selected as described above. The operator, instead of making connections in the multiple, makes connections in an outgoing trunk, which terminates in the office to which the subscriber called for is connected. The operator at the central office is required to operate an ingeniously designed key, which selects the subscriber called for. Such a system not only increases the capacity of the plant very decidedly, but eliminates all of the trunking operators and a large part of the A operators. It also eliminates the multiple, answering jacks, line lamps, one-half the cords and plugs, and the intermediate board. The line relays are still necessary, and, in addition, a simple device for selecting the position and cord to be used is required. By using branch offices with the trunk selectors the cost of the outside plant may be greatly reduced. One trunk for every ten subscribers would be sufficient for carrying the business between the main and the branch offices. The apparatus at the branch office is a simple one-motion selector which would select a non-busy trunk to the main office. In calling the subscriber there will be an additional motion required of the selector, which will be simple, owing to the fact that there is only a small number of subscribers entering any one of the branch exchanges. By having small exchanges there is but a small number of subscribers to select. Thus a simple indicator suffices. Further, the wire mileage is reduced owing to the small area served by each branch exchange. Such a branch office may be installed in any suitable, inexpensive location—either in a building, in a special terminal box or on a pole.

The system, as here outlined, makes use of the simplest known form of substation equipment. It effects a large saving in the outside wire plant, it eliminates most of the objectionable features of central office equipment as found both in the automatic and manual systems, and it furnishes a superior service, since it is more rapid than either the manual or automatic. Further, it makes it unnecessary for the subscriber to operate a mechanism and thus make his own call. The subscriber is not subject to delay due to a busy operator, and, moreover, the service is secret.

* Electrical Review (N. Y.)

THE OHM, VOLT, AND AMPERE.

THE great activity which has in recent years been displayed in the investigations aiming at the exact determination of the electro-motive forces of standard cells and of the electro-chemical equivalent of silver, is not only due to the zeal for scientific accuracy. The problems have direct practical importance. The Chicago International Congress of 1893 had fixed definite values for the ohm, the volt, and the ampere. As any t of these quantities determine the third, the Congress had gone too far, and careful redetermination of the electro-chemical equivalent of silver soon brought this fact home to electricians. With the customary experimental methods the difficulty seemed to affect the volt particularly; it resulted that the electro-motive force of the Clark standard cell, fixed at 1.434 volt at Chicago, was too high by 0.1 per cent. That uncertainty was too great to be tolerated in technical practice; and as meanwhile the electrical units had been legalized, all the three in some countries (e.g., in this country and in the United States), two only in others (in Germany, e.g.), an international agreement as to these matters was one of the chief questions discussed at the International Congress held at St. Louis in 1904.

The Congress was more cautious than its predecessor. Certain peculiarities of the Clark and Weston standard cells had not been sufficiently elucidated, and the interpretation of the laws concerning the electrical units in different countries was not uniform. The Congress, therefore, suggested an international commission, which, it was hoped, would become a permanent body. In order to arrive at a preliminary understanding, Dr. Stratfon, director of the Bureau of Standards at Washington, afterward proposed that a conference of delegates should meet in the first instance, and invitations to such an international conference were addressed by Prof. Kohlrausch, then president of the Reichsanstalt, to the institutions corresponding to the Reichsanstalt, and to a few leading scientists. The conference met at the Reichsanstalt in October last, where Prof. E. Warburg had succeeded Prof. F. Kohlrausch, who himself attended as one of the delegates. Germany was further represented by Dr. Lewald, Dr. E. Hagen, Dr. W. Jaeger, and Dr. Lindeck; Austria, by Profs. V. von Lang and L. Kusminsky; Belgium, by Profs. E. Gérard and P. Clément; England, only by Dr. Glazebrook, Lord Rayleigh not being able to come; France, by Prof. Mascart, who took the chair at five of the meetings, while Dr. Glazebrook presided at the sixth; the United States, by Prof. Carhart, of Ann Arbor University, Michigan; the Bureau of Standards at Washington submitted a memorandum. The chief question before the conference was the selection of the two fundamental units. Prof. Carhart advocated the ohm and the volt, because he considers the standard cell on the whole a more reliable practical standard instrument than the voltameter; in that case no regulations would have been necessary as to the silver voltameter. But the conference decided for the ohm—about which there was no doubt at all—and the ampere, although that involves definite regulations as to the standard cells. The decision may appear a little inconsistent, considering that the conference does not definitely settle how the ampere is to be determined. It recommends that silver voltameters be used, and that special regard be had to the researches of Richards and Guthe in this field; but that the electro-chemical equivalent Ag = 1.118 milligramme per second be maintained for the present. The conference was further unanimous in giving the Weston cell preference over the Clark cell; but, again, it did not go beyond fixing that a cadmium amalgam of 12 or 13 per cent be used, and that the electrolyte contain some solid cadmium sulphate, as in the standard cells of the Reichsanstalt.

We have to bear in mind that, basing ourselves upon Ohm's law, we check one of these units by the others, and that we have to effect the best practical compromise. Guthe's own value for the equivalent was 1.11682; the uncertainty comes in mainly through the electromotive force of the Clark cell, and at St. Louis Prof. Guthe appeared to trust his voltameters less than his Weston cells. But meanwhile, Van Dijk and Kunst have arrived at the value 1.1182, so that the 1.118 may well be adhered to. The other resolutions of the conference concern chiefly the determination of the standard of resistance. The measurements are to be made at 0 deg. C., by the differential method of Kohlrausch, the Kelvin bridge method, or the compensation method, and the tubes, if possible, of Jena glass, 59III, are to be filled without heating *in vacuo*. The desire was further expressed that the preparation of the standards should be fixed on a uniform international basis, and that the supervision of those standards should be intrusted to an international body, to be framed probably on the model of the International Geodetic Survey Commission. Some of the great countries have not electrical standards of their own; the United States, for instance, so far make use of the Reichsanstalt standards. These questions are, however, to be discussed further.

It is noteworthy that there was no divergence of opinion regarding one point which has occupied previous conferences. We mean the agreement between the practical units and their theoretical definitions. The theoretical unit of resistance is 10^9 electro-magnetic C.G.S. units, the unit of current intensity 10^{-1} C.G.S. unit. The practical units should, of course, fairly represent those quantities, but the closeness of agreement is a matter essentially of theoretical interest; and it would be useless and inconsistent to insist upon a legal sanction of theoretical definitions, such as the phrasing seems to imply: "The ampere is equal to 0.1 C.G.S. unit, and is sufficiently represented for practical purposes by . . ." For those methods are the only ones available for the determination of the units. The conference quite concurred in the arguments of its chairman. Prof. Mascart pointed out that, in the electrical units, as well as in the meter and the kilogramme, we have to distinguish between definition and prototype. The kilogramme is defined as the mass of a cubic decimeter of water at the temperature of 4 deg. C. The international kilogramme is the mass of a certain lump of an alloy of platinum-iridium. So far as we know now, definition and prototype agree within 3 parts in 100,000. But even if future research should reveal a greater discrepancy, the result would only affect strictly scientific researches, such as the absolute determination of the ampere, now carried out at the National Physical Laboratory.—Engineering.

ELECTRIC FURNACE FOR RESEARCH WORK AT HIGH TEMPERATURES.

DR. HARKER has invented a form of electric furnace in which small samples of metal can be heated to temperatures of 2,200 deg. C., without coming into contact with carbon or any noxious gases. The conductor conveying the electric current is a tube of similar composition to the filament of a Nernst lamp. For many purposes the usefulness and life of a furnace constructed in this way may be much increased by adopting a "cascade" system of heating; that is, the energy supplied may be divided, so that only sufficient is put through the tubular conductor to raise its temperature (say) 1,000 deg. C. above its surroundings, the surroundings being maintained at 1,000 deg. C., thus enabling a temperature of 2,000 deg. C. to be attained in the tube without straining it unduly. The regulation of temperature in small furnaces of this type is so perfectly under control that very well defined melting-points may be taken with very small quantities of substance. The thermo-electric method has been used in these furnaces for determining the melting-point of platinum, the mean result of the experiments giving 1,710 deg. C. ± 5 deg. C.

In the United States, the history of concrete practically starts with its use by the Engineering Corps of the army. At first, concrete was employed chiefly for foundations and for backing up other masonry. In the last twenty years, however, the development of modern ordnance has necessitated protection for land guns, of a sort unobtainable with earth, or—without great expense—with cut stone; on this account, and, also, because concrete when struck does not splinter so badly as stone, the body of the parapet of present-day batteries is being constructed of the newer material. From the use of concrete of large masses in this way, it has been an easy step to its use for lock masonry, breakwaters, etc. One of the earliest concrete dams was built at Rock Island, Ill., a few years ago, while the first use of concrete for an entire lock was on the Illinois and Mississippi Canal in 1894.

A LOW-RESISTANCE THERMO-ELECTRIC PYROMETER AND COMPENSATOR.*

By Prof. WILLIAM H. BRISTOL, Hoboken, N. J.

THE thermo-electric pyrometer herein described is adapted for commercial and every-day shop use.

It is similar in principle to the Le Chatelier pyrometer, but is of low resistance and instead of the extremely delicate suspension galvanometer a Weston special dead-beat milli-voltmeter is used, and in place of the costly platinum-rhodium elements, inexpensive alloys are employed for the couples.

The low cost of the couple makes it possible to keep

FIG. 1.

an extra one on hand for use as a standard to quickly and easily check the one that is in regular service.

The temperature at a number of localities may readily be observed on a single instrument, a couple and leads being provided for each locality in connection with a suitable switching device.

The same instrument may also be provided with scales for different total ranges.

For ranges of temperature up to 2,000 deg. F. instead of using porcelain tubes for insulation, each element of the couples is insulated with asbestos and a carborundum paint. Couples so insulated may be applied directly to the fire space where the temperature is to be measured, or where extra protection is desirable the couple may be slipped into a piece of common iron pipe with one end closed. Couples so protected are well adapted for use in liquids and molten baths, such as are employed for hardening and tempering of steel.

For instantaneous determination of the temperatures of molten metals as brass, bronze, etc., the ends of the couple are left disconnected and without insulation.

The same form of the couple may be used for quickly measuring the temperature of a metallic object. For this application the tips of the couple are pointed, so that the temperature at the two points of junction may become the same as that of the object immediately after the contact is made. This form of the couple affords a most convenient method for almost simultaneously measuring the temperature at different points of an object.

When desirable the couples are made with a separa-

FIG. 2.

ble junction, which permits the fire end to be removed and renewed at pleasure.

A compensator is adapted to automatically correct for atmospheric changes of temperature at the cold ends of the couple.

In order to make an equivalent and to reduce the cost of the platinum-rhodium couple for the measurement of temperatures above the fusing point of the low-priced alloys, a compound couple is formed with platinum-rhodium for the part to be exposed to the full temperature to be measured and of a length extending to a point where the temperature will not exceed 1,200 deg. F. The remaining portion of the elements of the couple are composed of inexpensive alloys.

Automatic continuous records of the indications of the pyrometer may readily be made on a chart sheet which is arranged to move at the proper speed back of the end of the indicating arm. This record sheet is unsupported over its active portion, which is periodically vibrated by the clock movement into contact with the end of the indicating arm and produces a record upon the chart sheet.

The record may be made by ink carried by the indicating arm, or the surface of the record sheet may be coated with some easily removable substance.

For automatically recording rapid changes of temperature a current from an induction coil may be passed through the record sheet from the end of the indicating arm at frequent intervals.

1. For a great variety of industrial processes and also in scientific research the ranges of temperature required do not exceed 2,000 deg. F.

2. The low-resistance pyrometer herein described has been developed to meet the existing demand for an instrument to fully cover this range of temperature; one which would be accurate, reliable and comparatively inexpensive, taking into consideration both the initial cost and the cost of maintenance; also one that might be readily adapted to varying conditions for industrial operations and be successfully operated by an ordinary workman.

3. As the title implies, this pyrometer depends primarily upon the well-known thermo-electric couple, consisting of two dissimilar metals or alloys joined at one end.

4. When the junction of such a couple is located at a point where the temperature is to be measured an electro-motive force is developed, which is a function of and depends for its value upon the difference of temperature at the junction and that at the opposite or so-called cold ends of the two elements forming the couple.

5. The phenomenon that an electric current is produced when the opposite functions of two dissimilar metals or alloys are of different temperatures was discovered by Seebeck in 1820.

6. Le Chatelier in his recent book entitled "High Temperature Measurements" states that in the year 1830 Becquerel had the first idea to profit by the Seebeck discovery for temperature measurements.

7. During the seventy-five years since that date many scientists have systematically studied and carried out investigations with thermo-electric couples, using a great variety of metals and alloys, with a view to discover a couple that would resist high temperatures and could be depended upon for constancy when used for their measurement. Le Chatelier who has made extensive researches to determine the most desirable metals for this purpose finally adopted a couple of which one element consisted of pure platinum and the other of an alloy of platinum and 10 per cent rhodium, from which couple an almost uniformly increasing electro-motive force is developed correspondingly with increasing differences of temperature between its opposite ends.

8. At the present time many of these couples are successfully employed for the determination of high temperatures. They are almost invariably used in conjunction with an extremely delicate high-resistance galvanometer, which, according to Le Chatelier, is indispensable, 200 ohms being mentioned as a minimum resistance allowable in the indicating instrument. This amount of resistance is necessary to practically eliminate the atmospheric temperature influence upon the resistance of the elements forming the couple, the leads and the coils of the galvanometer itself.

9. If the galvanometer be of a high-resistance type it is evident that if sensitive to the minute current of electricity corresponding to the very low electro-motive force produced by the couple, it must be delicately constructed and consequently requires great skill and care in its handling and operation.

10. The sensitive coil of the instrument is usually suspended by an extremely fine wire and the instrument must always be leveled and located upon a solid foundation before the observations can be made.

11. The platinum-rhodium couple instrument above described may be classed as a high-resistance pyrometer when compared with the *low-resistance pyrometer* of which the following is a description:

12. It consists of three parts: couple, indicator, and leads to connect couple and indicator. The leads between the couple and the indicator may be of almost any desired length to meet the special requirements; the combined resistance of the leads, couples and indicator is fixed to suit the total range of the instrument and varies from 3 ohms as a minimum to 10 as a maximum. The indicator is a low-resistance instrument of special design, and is made especially for the writer by the Weston Electrical Instrument Company. The accuracy, permanency, and portability of these instruments are well known.

13. Fig. 1 shows a wall or switchboard form of the indicator. Fig. 2 illustrates a portable form. These indicators are made with pivots in jeweled bearings in place of the delicate suspension by fine wires which are generally considered necessary in the high-resistance type of indicator or galvanometer for this work.

14. The elements used in the low-resistance system give a much greater electro-motive force than the platinum-rhodium couple, which is a great advantage in gain of motive power for the operation of the indicating instrument.

15. The particular metals or alloys applicable for a pyrometer of this type should have a fusing point higher than the maximum temperature to be measured; and when formed into a couple should produce a high electro-motive force with practically uniform increase of same proportional to the increase of temperature.

16. As the result of many experiments with different metals and alloys to determine suitable materials to meet these requirements, couples have been finally

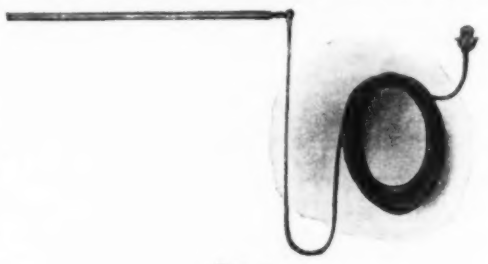


FIG. 3.

adopted which consist of alloys of tungsten, steel, nickel, iron, and copper; different alloys being employed to suit the total ranges of temperature that it is desired to have the scale cover.

17. Since no rare metals are used for the couples, this part of the pyrometer is inexpensive and it is possible to employ elements of large cross-section, which will not be affected in their resistance any appreciable amount by the variation of temperature along the lengths of the elements forming the couple.

18. The leads to the indicator are made of flexible insulated copper duplex cable and of ample cross-section to practically eliminate the influence of variations of atmospheric temperature.

19. The cross-section of the elements of the couple is reduced at their junction, thus rendering it sensitive to sudden changes of the temperature to be measured.

20. A novel feature of the couple is that it is made separable at the point where it passes through the wall of the space within which the temperature is to be measured.

21. The object of the joint is two-fold: first, to make it possible to renew the "fire-end" whenever it may be necessary; and second, to permit carrying the cold ends of the elements to a point toward the floor where the atmospheric temperature will be constant and not influenced by the temperature that is being measured.

22. Fig. 3 shows a complete element with separable joint, coiled leads and lamp plug on the end of the cable forming the leads for convenient connection to the indicating instrument shown in Fig. 1.

23. A special feature of the joint is that it is provided with large bearing surfaces to prevent possibilities of variations of resistance at the connection and is constructed to allow for easily breaking and making the connection. The details of the joint are shown clearly in Fig. 4, and from this it will be seen that it is impossible to make the connection incorrectly, as is usually done when there is nothing to guard against it.

24. The low cost of the couples makes it practicable for the user of the instrument to keep an extra fire

FIG. 4.

end in reserve, which may, at any time, be quickly substituted for the one that has been in continual service, thus affording an economical and positive check upon the accuracy of the instrument.

25. The elements of the couple are independently insulated in a novel and effective manner by winding each with asbestos cord and then coating the surface with carborundum paint, a solution of silicate of soda being used as a binder. This makes a clean, compact, and smooth insulation.

26. Couples thus insulated are flexible and can either be applied to the heated space directly or they may be inserted into a piece of ordinary pipe as a protection. This protection has proven itself to be effective and economical.

27. For continuous applications of the couples to temperatures in the neighborhood of 2,000 deg. F. or over, special protecting tubes of nickel, plumbago, or porcelain are employed.

28. These pyrometers are furnished with scales for

* Presented at the January 1906 Reunion in New York city and presented at the Chattanooga meeting (May 1906) of the American Society of Mechanical Engineers and forming part of vol. xxvii. of the Transactions.

For further discussion on this topic consult Transactions as follows: No. 23, vol. 2, p. 42: "Use of the Calorimeter as a Pyrometer for High Temperatures," J. C. Hoadley. No. 65, vol. 3, p. 187: "Specific Heat of Platinum, and Use of the Metal in the Pyrometer," J. C. Hoadley. No. 874, vol. 22, p. 149 "Recording Air Pyrometer," William H. Bristol.

total ranges of 600, 1,200, 2,000, and 2,600 deg. F. Reproductions of these scales are shown in Figs. 5, 6, 7.

29. The graduations of these scales are determined by the fusing temperatures of lead, zinc, aluminium, and copper; which give sufficient points on the curves for use in making a complete graduation of the scales.

The divisions are also further checked by the use of a standardized Le Chatelier platinum-rhodium couple and a Siemens-Halske suspension galvanometer.

For very open scales over shorter ranges several couples may be placed in series, thus making it possible to read to small fractions of a degree.

30. A novel application of the thermo-electric couple is that of determining the temperature of molten metals, as cast iron, copper, brass, and bronze. It

FIG. 5.

consists in leaving the ends of the elements disconnected and without insulation. When these ends are slightly immersed in the molten metal it makes a junction between the elements and the reading will be the same as if the elements of the couple had been originally joined. The advantage of this plan is that the reduced cross-section at the ends of the couple allows it to almost instantaneously attain the temperature of the molten metal, consequently there is no lag error—a most important advantage. As the couple is used over and over again, the ends become worn away, but the couple is, nevertheless, always ready for use by immersion of a fresh portion, which will not be changed in any way by continued use and will give the same reading for a given temperature as if the couple had not been worn away. A joint is provided near the end that is immersed so that a fresh tip can be applied to the couple before enough of the end has worn away to appreciably affect the resistance of the complete system.

COMPENSATORS.

31. As already mentioned, it is well known that the electro-motive force generated by a thermo-electric couple is a function of the temperatures at the hot and cold ends.

32. For refined measurements it is therefore neces-

FIG. 6.

sary to make allowance for changes of temperature at the cold ends of the couple when readings are taken unless some means is provided to maintain them at a constant temperature. This is sometimes done by immersing the cold ends in ice water or by having a water jacket around the ends through which there is a flow of water at some known temperature.

33. In the low-resistance thermo-electric pyrometer system, comparatively small changes in the actual resistance of the circuit, including couple, leads, and instrument, will produce sufficient effect to correct for atmospheric changes at their cold ends.

34. A compensating device to automatically correct for changes of atmospheric temperatures at their cold ends has been devised which makes it possible to dispense with the cumbersome means for maintaining the cold ends at constant temperature or the necessity for taking readings of temperatures at the cold ends.

35. This compensating device is shown in Fig. 8. It consists of a glass bulb with a short stem, similar to an ordinary mercurial thermometer. Two platinum terminal wires are fused into the stem near its top. These are connected within the bore of the stem by a loop of fine platinum wire, thus completing the circuit as indicated in the diagram. The size of the bulb, the

FIG. 7.

cross-section of the bore of the stem, and the cross-section of the platinum wire loop are proportioned to suit the case in hand.

36. The compensator will perfectly compensate for any particular point on the scale, as, for instance, the working point, where it may be desired that the reading shall be absolutely independent of changes of temperature at the cold ends. It will readily be seen that if the temperature rises at the cold ends the mercury rising in the stem will short-circuit a certain portion of the platinum loop, thus reducing the resistance of the entire circuit by exactly the necessary amount so that the diminished electro-motive force of the couple due to the rise of temperature of the cold end will send the same amount of current through the circuit and instrument, and consequently give the same reading as if there had been no change of temperature at the cold ends.

37. The compensator acts on precisely the same principle, but in a reverse manner, when the temperature falls at the cold ends, the resistance of the circuit being increased as the column of mercury lowers in the stem. The increase produced in the resistance of the circuit prevents the increased electro-motive force of the couple due to the fall of the temperature at the cold ends from sending an increased current through the instrument, therefore the reading remains unchanged. The compensator may also be employed within the indicating instrument to correct for atmospheric changes of temperature upon the instrument itself where extremely accurate results are required.

38. It will be seen that a compensator of the form described cannot as conveniently and practically be applied to a high-resistance indicating instrument.

GENERAL ADVANTAGES OF THERMO-ELECTRIC PYROMETERS.

39. As compared with other forms of apparatus for measurement of high temperatures, the thermo-electric pyrometer has many advantages, of which the following are the most important:

They may be employed where the space is extremely small and inaccessible. They are practically independent of temperature variations intermediate of their hot and cold ends. They are independent of pressure and rough usage at the point where the temperature is desired to be measured.

40. The indicating instrument can be located at the most convenient point, practically at almost any distance from the couple. They are extremely sensitive to changes of temperature and respond instantaneously—that is, there is no lag error. They are constant in their indications when the couples are properly protected. They permit the determination of the temperature at many different points by means of several couples and leads connected to one instrument, provided with suitable switching device.

SPECIAL ADVANTAGES OF LOW-RESISTANCE SYSTEM.

41. The important advantages of the low resistance of thermo-electric pyrometer system may be summarized as follows:

First. A commercial switchboard or portable dead-

FIG. 8.

beat indicating instrument may be employed instead of the extremely delicate suspension galvanometer required for use with a single platinum-rhodium couple. This advantage is gained by the fact already stated, that the thermo-electric couples employed give several times as much electromotive force as the platinum-rhodium couples, which is ample to successfully operate a pivot instrument if of sufficiently low resistance.

Second. It affords a practical method for automatically compensating for the changes of temperature at the cold ends of the couple, as already described.

Third. It makes it practicable to use the same indicating instrument and the same couple for different total ranges of temperature by using different binding posts and having several scales drawn, the proper resistances being inserted for each individual total scale.

Fourth. The application of low-priced metals and alloys as a substitute for platinum and rhodium makes it possible to install a number of couples, and by means of proper switching devices use on instrument for quickly determining the temperatures at the locations of the different couples. In many instances the first cost of the expensive platinum elements prohibits their use in this way.

APPLICATIONS.

42. Many applications of this instrument will suggest themselves. A few of the important ones are mentioned, as, for example: in a boiler test where nineteen couples were simultaneously applied at different points between the furnace and the flue. From the data obtained a curve was drawn showing the temperatures at all points along the path of the products of combustion from the furnace to the flue, the abscissas corresponding to the square feet of heating surface, and the ordinates to degrees Fahrenheit. The value of such data for investigating and studying the economical working of steam power plants will be appreciated. The couple can readily be applied to the steam space of a boiler and used to show the degree of superheating.

43. These instruments have also been adapted to and are especially valuable in maintaining the desired temperatures for annealing, hardening, tempering and bluing of steel.

44. When many small parts are handled, as in the manufacture of watches, a practical method of using the pyrometer is to adapt the pot containing the articles to the end of the couple and using it as a handle for inserting the pot into the furnace or into an ordinary forge fire. By revolving the pot it is heated perfectly uniformly, and as soon as the proper tempera-

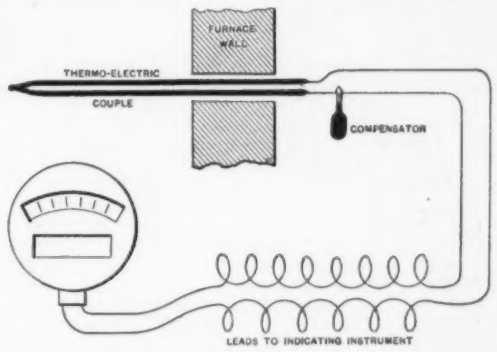


FIG. 9.

ture is reached it is known on the indicator, and all guesswork is eliminated.

45. They have been most successfully employed in lead-hardening baths. For this purpose the couples are protected by wrought-iron pipes, and will last for months without renewal. After constant daily use for many weeks the couples give the same readings as when first installed.

46. In addition to making it possible to obtain absolutely uniform results with a given lot of steel it has been found that the life of the pots has been increased, as they are not overheated. From this fact it naturally follows there must be an economy of fuel as a result of using the pyrometer.

47. Application has also been made by galvanizing baths, affording means for keeping the molten metal at the proper temperature for the work, preventing overheating and wasting zinc by vaporization.

48. They have been used to keep molten lead at correct temperature in the manufacture of shot.

49. These instruments have also been tried and are now being tested for indicating the temperature in the carbureter and superheater of a Lowe water gas plant.

50. Where the process of gas-making depends upon proper temperatures and the pyrometer shows when the steam and oil should be turned off and the blast turned on, and also when these operations should be reversed in order to obtain the most efficient results.

51. By using two or three couples in the carbureter it is possible to adjust the spray of oil so that every part from center to shell will be working to the best advantage.

52. The instruments have also been successfully employed in chemical works.

53. The field of usefulness seems to be very broad, as the instrument can be adapted to meet almost any individual requirement.

DISCUSSION.

Mr. Gus C. Henning stated that the simplicity and cheapness of the couple is also a very advantageous matter, and its interchangeability is unique.

The fact that temperatures can be correctly and continuously recorded is a great advantage.

With this apparatus the expert heater is no longer the most important personage in a works, and cannot play the tyrant as is so commonly the case. Once having determined proper temperatures in furnaces for different classes of work, these can always be reproduced and maintained, and it is no longer a matter of guesswork.

Moreover, one such apparatus with a switchboard makes it applicable to a great many furnaces at the same time.

Mr. Henry Souther said the use of a pyrometer in a

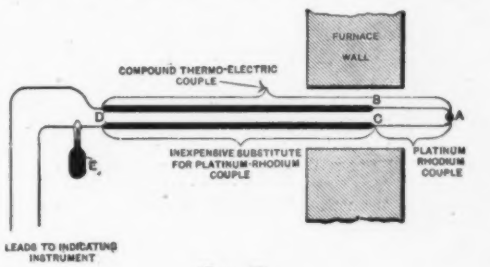


FIG. 10.

furnace where there are hot and cold drafts is always unsatisfactory, and he believed always will be. If the pyrometer is to be used in a furnace it should actually be buried among the parts or in the material being heated, and not subjected to the drafts of a furnace.

The ideal use for a pyrometer is in connection with a molten bath of lead, cyanide, salt, or whatever may be convenient. The temperature of such a bath can be perfectly measured, and the material immersed in it acquires the same temperature if left there long enough. The personal equation of the operator disappears almost entirely, which is not the case, nor can

it be in connection with a furnace where the couple is suspended over or near the work, and not actually in contact with it.

Prof. Bristol's thermo-couple will stand a lot of abuse, and, better yet, will stand immersion in molten baths for a considerable length of time. His electrical instrument is not of the delicate type peculiar to the high-resistance platinum, platinum-rhodium couple.

Mr. R. L. Penney, experimental engineer at Winchester Repeating Arms Company, New Haven, Conn., stated that in manufacturing firearms it becomes necessary in many cases to be able to determine quickly the temperatures of baths, furnaces, etc.

The first kind of pyrometer used was one made by one of the well-known companies, but we soon found this kind to be as variable as the weather, and could not be depended upon for anything like accurate work.

The Le Chatelier was then tried and found to give excellent results, but it was too delicate to be generally employed for shop use. It required a rigid foundation, and even then the fiber used to suspend the needle would break occasionally, besides trying to keep the temperature of the cold junction constant or at zero degree C. was very difficult.

Beginning with last June, we have introduced the William H. Bristol thermo-electric pyrometer, and at present we are using it in four different branches of our work, hardening, tempering, bluing, and annealing, also using it in place of the Le Chatelier for experimental work. The results obtained so far leave very little to be desired. The instruments are arranged so that the workman knows just what he is doing, and the element of doubt is eliminated.

The hardening furnaces each have a couple, a compensator, and a set of leads, while one instrument does for all. The instrument is placed on the wall in a place convenient for all the workmen; near it is a small switchboard containing a switch for each furnace, the switch having a common connection to the instrument. The leads are brought from the several furnaces to the individual switches. The furnaces and switches are numbered to correspond. By this means a workman, who, we will say, is working on No. 4, is required to keep his furnace at a certain temperature. He goes to the switchboard and throws in No. 4 and reads the temperature directly, without making any correction, without waiting for an oscillating needle to come to rest. The couples are introduced into these furnaces from the back, the fire-ends being inclosed in a porcelain tube. These couples have required no attention since they were set up.

The same scheme is applied to our tempering and bluing baths, using a lower range instrument. In these last two applications accuracy and permanency are very essential points.

With these pyrometers as now in use we are enabled to obtain results that are unchanging from day to day.

In annealing these instruments and couples are of great benefit. On account of the inexpensiveness of these couples we use two for each furnace, one to measure the temperature of the furnace and another to measure the temperature at the center of the box containing the work to be annealed. The leads from each couple are carried to a double-throw switch. The workman in charge throws the switch one way to find the temperature of the furnace, and the other way to find the temperature of the work.

The two couples are introduced together through the side of the furnace, one reaching into the furnace a short distance, and the other extending through the fire space into the center of the box through a hole in its side. This arrangement has been found to be satisfactory and enables the workman in charge to handle the furnaces as if they were machines, slacking and starting them up as necessary.

Having compared the Bristol pyrometer with the Le Chatelier and finding it accurate, we have used it for experimental work in many cases, of which the following is an example: Wishing to determine the rate of the rise of heat in a case of cartridges and the temperature at which they would explode, when heated gradually from the outside, two couples were introduced into the case, one a short distance and the other into the center. The instrument was about 90 feet distant, and heat was applied to the outside of the case, which was inclosed in a sheet-iron oven. The heating continued until all the cartridges had exploded. The cartridges exploded one by one, there being no general explosion. On examining the couples after the explosion they were found to be bent and twisted out of shape, but no indication of this was shown on the instrument during the experiment. One looking at the instrument would not guess that the couples were being used so roughly. The temperature rose steadily to a maximum and then dropped. If it had been necessary to use two platinum-rhodium couples this would have been an expensive and difficult matter.

We have found the Bristol pyrometer to be one that can be applied to every-day shop problems successfully.

STEREOSCOPIC EXAMINATION OF BANK NOTES.

ONE of the most accurate methods of examining a bank note, with a view to determining whether it is or is not genuine, involves the use of a stereoscope. If two authentic bank notes are adjusted and viewed in a stereoscope, the resulting image appears perfectly flat, since the images seen by the two eyes are precisely similar. If, however, one of the notes is not genuine, the slightest variations in the superscription produce relief effects, the printing appearing to stand out in some places, and to be recessed in others.

TIMES AND PLACES OF EARTHQUAKES.*

By Prof. H. H. TURNER, F.R.S.

THE occurrence of several disastrous earthquakes and eruptions during the last few months inevitably suggests the question whether all these events may not have a common and determinable origin. To avert any of these disasters, even to modify them in the slightest degree, may be entirely hopeless; but the vaguest foreknowledge of their probable occurrence might be of untold value in saving life and property. Has modern research obtained any clues which enable predictions to be made, or promise that prediction may be possible in the near future? It must be frankly admitted that as yet our knowledge is so slight as to have no commercial value; but still, there are one or two clues in the hands of those working at the subject which may ultimately lead them to more directly useful knowledge. We have learned something of the regions where earthquakes occur, and something of the times when we may specially expect them; and, though the something is in each case a very little, the magnitude of the issues involved lends it interest.

Systematic observation of earthquakes is only about a quarter of a century old, and for fairly complete records of all the shocks occurring in different parts of the globe we can date only from 1892. Before that date information could only be collected on the spot, and was thus frequently lost; but it was realized about 1890 that a series of earthquake observatories, with delicate instruments, could obtain records of shocks in any quarter of the globe, and identify the spot with certainty, even if there were no witnesses of the actual occurrence. From the records of these observatories it appears that there are every year some 30,000 minor shocks of earthquake in different localities, but of these only sixty are "world-shaking" and observable from a great distance. Such numbers indicate immediately that, from one point of view, the San Francisco earthquake cannot be regarded as exceptional; it was only one event out of sixty per annum. What rendered it disastrous was the existence of a great town in the shaken locality. But was the neighborhood known to be a dangerous one? Was it, at any rate, suspected, so that the building of a great city there was an error of judgment? And is it advisable to rebuild the city in the same place? These are questions of the gravest importance; and it is well worth while to review the little knowledge already accumulated with the utmost care to see whether it will give us even provisional answers to them.

Prof. Milne, in the tenth report of the British Association Committee, refers the "world-shaking" earthquakes observed in the six years 1899-1905 to thirteen great earthquake regions, designated by the first thirteen letters of the alphabet. Three of these—I, J, and L—are responsible for only five, three, and two shocks, respectively, and are thus of small importance compared with the others, which average about forty shocks each. Excluding them for the present, the remaining ten regions lie approximately in two rings on the earth's surface, a configuration which is most strikingly apparent when the regions are marked on a globe. The more important ring includes the following seven regions: A (Alaskan coast), B (Californian coast), C (West Indies), D (Chilean coast), M (south of New Zealand), F (Krakatoa region), and E (Japan). Its center is among the conspicuous group of islands which includes Tahiti, and the radius of the ring is about 65 degrees. The other ring has its center at the opposite point of the earth, which is in the Sahara Desert; and at a radius of 50 degrees from this center lie regions G (between India and Madagascar), H (the Azores), and K (Tashkend). Now, this is not merely a convenient geographical summary, but a physical fact of vital importance, according to recent researches of Prof. Jeans.

In a remarkable paper read before the Royal Society in 1903 he gave reasons for believing that the earth is by no means a sphere or a spheroid, as we have been accustomed to think, but is of a pear shape.

Under the gravitational stress it is continually approaching the spheroidal form—the pear is being crushed into a sphere by its own attraction, and the result is a series of earthquakes. These naturally occur in the weakest places, and if any one will experiment in crushing a pear toward a spherical shape, or even draw a diagram and consider where the weakest points would be, the reasons for the existence of two rings of greatest weakness will readily suggest themselves. The ends of the pear are the centers of these rings, one in Africa, one in the Pacific, and when once this is pointed out the pear shape of the earth is, according to Prof. Sollas, "obvious to mere inspection; it is a geographical fact and not a speculation." Prof. Sollas is indeed responsible for the particular suggestion above sketched, for Prof. Jeans had originally proposed a different axis, which he withdrew in favor of the obvious improvement. The confirmation of Prof. Sollas's view from the distribution of earthquake centers is remarkable. It does not seem, however, quite certain which is the blunt end of the pear; it has been hitherto placed in Africa, but there seem to be several reasons for regarding Africa as the stalk end. This point cannot, however, be dealt with here. The important thing is that there seems to be a real reason for the occurrence of earthquakes in these particular regions, and that they will probably continue to occur there. Prof. Jeans's conclusions have recently been examined by Lord Rayleigh, who announced at the Royal Society only a few weeks ago that he found them generally confirmed, and that we must regard our earth as at present in a state far from stable.

The lessons to be learned from the distribution of earthquakes in space are accordingly tolerably plain in theory, though in practice we may not be able to take advantage of them. If we would be particularly safe from earthquakes we must take up our abode near one of the ends of the pear—either in Africa or in the Pacific. There is also a region of safety between the two dangerous rings—in America generally, for instance, excluding the West, or in Siberia. But the dangerous regions include so vast and so valuable a part of the earth's surface that it is impracticable to leave them unoccupied. Moreover, our knowledge is as yet not specific enough. In the dangerous regions themselves, some parts are much more dangerous than others; for instance, Japan, which is reckoned above as a single region, can be divided into at least fifteen distinct seismic districts. As observations are accumulated we may be able to make similar partitions of the other regions. For the present the general attitude toward earthquakes will probably be similar to that toward other dangers, such as those of travels and voyages for instance; the risk must be incurred. We know that there are at times fatal tornadoes, but other interests are at stake, and we put to sea in the hope that none will occur during our voyage.

We come to the second point, the distribution of earthquakes in time. Are there seasons of special activity such as the recent occurrence of several disasters seems to suggest? Here our knowledge is slighter still, and the observed facts have not yet been co-ordinated by a mathematical investigation. Still there seems to be some evidence in support of the view that exceptional irregularities in the rotation of our earth may be responsible for an increased number of earthquakes at particular times. That the evidence is slight must be attributed to the shortness of the time during which it has been possible to obtain it, and not necessarily to inherent weakness in the evidence itself. The brevity of the earthquake record has been mentioned above; that of irregularities in the earth's rotation is longer; but the discovery that such irregularities existed was made only twenty years ago, though the phenomenon was then traced back through the old observations. The irregularities are systematic in character, and the law governing them is approximately known already; so that, if the presumed connection between them and earthquakes is confirmed, we may be able to predict periods of great earthquake frequency. Such periods would be in some respects analogous to the times of spring tides.

It is a familiar fact that at new and full moon the tides are much greater than when the moon is at the quarters. The reason is that we have two tide-raising bodies, the moon and the sun, which sometimes act in concert, and then we get large tides; sometimes in opposition, and then we get small tides. If the influence of these two bodies were more nearly equal, instead of the moon being so predominant a partner, we can imagine times when the tides would be barely perceptible. Similarly there are apparently two contributors to the variation in our earth's rotation, which sometimes act in unison and sometimes in opposition. They are more nearly equal in influence than are our moon and sun, and consequently there are times when these two contributors nearly balance one another and the axis of rotation remains almost steady. But in due time the contributors reinforce one another and the axis acquires a considerable "wobble." Each end of the axis then describes a curve composed of wide sweeps and sharp bends, and the evidence seems to be that at the sharp bends we are particularly liable to earthquakes.

The exact statement of the case as given by Prof. Milne in his Bakerian lecture, "Recent Advances in Seismology," delivered before the Royal Society on March 22 last, is as follows:

"In a period of nearly thirteen years (1892 to 1904) I find records for at least 750 world-shaking earthquakes, which may be referred to three periods continuous with each other, and each two-tenths of a year, or seventy-three days' duration. The first period occurred when the pole movement followed an approximately straight line or curve of large radius, the second equal period when it was undergoing deflection or following a path of short radius, and the third when the movement was similar to that of the first period. The numbers of earthquakes in each of these periods taken in the order named were 211, 307, and 232—that is to say, during the period when the change in direction of motion has been comparatively rapid the relief of seismic strain has not only been marked, but it has been localized along the junctions of land blocks and land plains, where we should expect to find that the stress due to a change of direction of motion was at a maximum. Until the magnitude of these induced stresses has been estimated it would be premature to assume that the frequency under consideration is directly due to change in direction of pole movement, it being quite as likely that both phenomena may result from a general cause."

It is eminently to be desired that a mathematical investigation of the point should be undertaken; but the difficulties are very great, and as yet no one has had the time and courage to attack them. It will be seen, then, that the seismologist is as yet not able to give forecasts of any commercial value, though he is by no means without hope of doing so.

There are, however, some lessons of immediate practical importance which have been learned by seis-

* London Times.

mological study; we may again quote from Prof. Milne's Bakerian lecture:

"At the Imperial University of Tokio a platform was constructed which by means of powerful machinery could be made to reproduce earthquake motion of varying intensity. On this table large models of masonry, wood, and metal designed to resist expected seismic accelerations were tested. This table has been to the builders in Japan what a testing tank in a dockyard has been to constructors of large vessels. The ultimate result of these and other investigations has been to modify and extend the rules and formulæ of ordinary construction, and now in Japan, as opportunity presents itself, new types of structure are springing up. These have withstood violent shakings which have materially damaged ordinary types in the neighborhood. While much has thus been done to reduce the loss of life and property, the Japanese government, stimulated by the results of this experience, has been encouraged to extend its support to seismological investigations in general.

"In 1886 the chair of seismology was established at the Imperial University, and since 1892 there has been in existence a Seismological Investigation Committee, which has already issued seventy quarto volumes. At the Central Meteorological Observatory in Tokio records are received from nearly 1,500 observing centers."

From these paragraphs it will be seen that there are questions which merit the close study of engineers and architects whose work lies in the dangerous regions, though but little attention has been paid to them except by that wonderful little people who have already taught us more than they learned from us. It is some consolation, doubtless, to reflect that modern seismology owed its origin to Englishmen.

It will, no doubt, be objected to this comparison that an important consideration has been omitted. Seismological questions are of urgent practical importance in Japan, but not in England and eastern America. That is true, and we all hope that it may remain true; but our guarantee is not absolute. Whether the regions of danger are permanent or shifting is just one of the questions which the whole world is interested in answering, and which can be answered only by patient and laborious research. The British Isles are far from being in a specially safe region; in fact, they lie almost exactly on the smaller dangerous circle above mentioned, through Tashkend, the Azores, and the Indian region; and though earthquake activity seems to be at present limited to these three regions, and so far as it strays in our direction seems to find an outlet rather beyond us (in the region labeled J by Prof. Milne, between Iceland and the North Cape, where three earthquakes were recorded in six years), we have no right to assume that this state of things is more than temporary.

During the last year or two, however, more has been done in Europe generally to follow the lead of Japan; international co-operation in seismological work has been organized in Germany, and though the adhesion of some important countries is not yet certain, owing to various difficulties which need not be noticed here, it is hoped that these may be smoothed away in time. If so, we may look forward to a welcome strengthening of the corps of workers in seismology, though there is still more than enough work for them all to do.

ENGINEERING NOTES.

The indicated horse-power of the modern simple freight locomotive tested may be as great as 1,000 or 1,100; that of a modern compound passenger locomotive may exceed 1,600 horse-power. The maximum indicated horse-power per square foot of grate surface lies, for the freight locomotives, between the limits of 31.2 and 21.1 horse-power; for the passenger locomotives, between 33.5 and 28.1 horse-power.

The general stores department of a machine shop is of immense importance, for on it depends very much the profit or loss that the company will incur. The only possible way to prevent shortage, to reduce stock to a minimum, to keep an exact inventory of material on hand, to make certain that all outgoing material is charged to the right account, and to prevent delays in the manufacturing department by having ready to deliver the proper material at the required time, is to create a general storekeeping department for finished and unfinished material in charge of a good general storekeeper, and under him a sufficiency of clerks.

Mr. J. Emerson Dowson, in a recent communication, referred to some tests which were taken by independent engineers upon a number of gas generators of his own design, ranging in size from 150 horse-power to 375 horse-power. The coal consumption during stand-by hours varies from 1.8 pounds to 3.8 pounds per hour; the mean of four tests in four different towns, each taken by separate engineers, showed a consumption of 3 pounds of anthracite per hour. Mr. Dowson further obtained from engineers in charge of steam plants particulars of the consumption of fuel with various types of boilers standing-by, the size of boilers ranging from 150 horse-power to 500 horse-power. The mean of eight tests showed a consumption of 75 pounds of coal per hour, simply to keep steam in the boilers at working pressure, and not including losses by radiation in steam pipes, auxiliaries, etc., which are also appreciable items. The author has also made tests in several stations with which he has been connected, the results showing that in many small stations the amount of fuel consumed without doing beneficial work may be anything up to 40 per cent of the amount of coal consumed annually.

ELECTRICAL NOTES.

Measurement of Telephonic Currents.—An interesting discourse on the measurement of telephonic currents was given by Mr. W. Duddell at the Royal Institution. The chief experiment of the lecture consisted in showing simultaneously on a screen four series of waves indicating respectively the motion of the transmitter diaphragm, the wave-form of the current entering the line, the wave-form of the current at the receiving end of the line, and the motion of the receiver diaphragm. Various vowel sounds were spoken into a speaking tube connected to the transmitter, and the effect of adding inductance and capacity in the artificial line was demonstrated by the shape of the curves. A thread was fixed to the diaphragm in each case and transmitted the motion to a light mirror fastened to a wire round which the thread was wound once, and the time element was given by a moving mirror driven at a uniform speed by an electric motor. The line currents were measured by oscillographs, and the same moving mirror was used to give the time element. The whole arrangement of apparatus was a marvel of ingenuity and of fine adjustment. Mr. Duddell's lecture was mainly devoted to emphasizing the necessity of measurement in telephonic research, and he described various methods of making these measurements, the delicate micrometer due to Prof. P. E. Shaw for measuring the amplitude of the motion of a telephone diaphragm, the thermo-galvanometer and the oscillograph. For producing a pure sound Mr. Duddell uses either Mr. A. Campbell's vibrating bar or his own toothed-wheel inductor alternator. Incidentally also the lecturer called attention to the results recorded in Dr. H. B. Hayes's St. Louis Congress paper in 1904, in which the advantage was shown of "tapering off" at the ends the inductance of a "loaded" telephone line.

An invention which it is anticipated will prove of great value to the economical operation and efficiency of the long-distance underground telegraph cable between London and Birmingham has been patented by Mr. Viall, one of the engineers of the British General Post Office. On this particular cable quadruplex working giving four channels on a single line was found impossible without the utilization of a metallic loop, owing to the power that is used being so high that all the other wires in the cable were disturbed by induction when an attempt was made to use an earth return. The employment of the metallic return caused a reduction of some 50 per cent in the power; and though induction was very greatly diminished it was not removed entirely, and working was slower than with the aerial lines between the two points. With the Viall device, however, a low-power quadruplex system is provided, which enables working to be carried over a single line of the cable with an earth return. The invention is an adaptation of the decrement quad fitted with a single four-pole relay having two individual tongues, one of which is affected by the reversal of the current, and the other by the decrease in its power. By this means it is possible to double practically the carrying power of the underground cables, as prolonged tests with the system over the Birmingham-London underground cable have conclusively demonstrated. It has been in operation on this line for several weeks past with complete success. On this cable the power for the quad has ranged from 45 to 50 volts for one side of the quad and from 100 to 120 volts for the other side of the quad. By means of the Viall arrangement the potential has been reduced to 20 and 50 volts respectively, showing a decrease in the necessary power of at least 50 per cent.

In an article on the Polarization in Vacuum Tubes, published in Ann. d. Physik, G. C. Schmidt points out that the fact that a current between transverse electrodes in a vacuum tube passes more easily when the main discharge is passing than when it is not, may be explained by the increased density or mobility of the ions, but all exact measurements are subject to error on account of the polarization of the electrodes. The author studies this polarization by means of a new mercury interrupter, which enables him to break the main discharge and close the transverse current in rapid succession. He finds that even when driven at the highest speed the apparatus shows no perceptible polarization current. If it exists at all, it is less than 10^{-11} ampere after 0.025 second. The transverse conductivity is the same throughout the tube, and is due to ions gradually liberated from the walls of the tube. It is sensibly independent of the temperature. All these facts prove that the polarization is not of the same type as electrolytic polarization in cells, that is to say, it is not due to a chemical alteration within the material of the electrode. Further experiments show that the polarization is most likely due to a shortage of ions. On exposing a further surface of the electrode, the shortage is halved, and hence also the polarization. The current density therefore remains the same. The polarization is least in the glow light, and greatest in the cathode dark space. When the probe is charged negatively, it attracts positive ions, which give up their charges and produce the current. The supply of positive ions may become exhausted, and leave only the negative ions about the negative probe, and these would constitute the polarization. On changing the current strength of the main discharge, the strength of the transverse current changes in the same proportion, the polarization remaining the same. As regards the anode and cathode falls at the probes, the author finds that both are much greater in the cathode dark space than in other parts of the discharge, owing, no doubt, to its poverty in ions. They increase most rapidly with the current when the probes are immersed in the glow light. The anode fall is greater than the cathode fall in the cathode dark space, but in the other parts of the discharge the reverse is the case.

SCIENCE NOTES.

The method of determining the character of a water from the ratio that exists between the carbon and nitrogen, being recognized as of comparatively little practical worth, on account of the difficulty of determining the carbon, attention to-day is concentrated upon the nitrogen content of a water. The usual method used for determining the nitrogen in the undecomposed nitrogenous compounds is the albuminoid ammonia method of Wanklyn. It gives only an approximation of the total amount of nitrogen thus occurring, but taken in connection with the free ammonia present it undoubtedly often gives valuable indications as to the source of the nitrogenous compounds.

Recent excavations at Pompeii have resulted in the discovery of a remarkable fresco depicting the "Birth of Rome," some interesting particulars concerning which are furnished by Prof. Dall Osso, of the National Museum at Naples. The subject is divided into four scenes, and represents four incidents in the story of the foundation of the city. The first scene takes place in Heaven, showing Helios in his chariot rising on the horizon, and Mars in golden armor with a lance in his right hand as the center piece. The second tableau represents the House of the King of Alba with Rhea Silvia, daughter of Numitor, reclining asleep on a small hill on the right-hand side, with the Temple of the Priests of Mars on the left-hand side. The third shows the punishment, by drowning, of Rhea Silvia, who, though a vestal virgin, yielded to Mars and became the mother of Romulus and Remus. The fourth incident portrayed is the course of the Tiber, near which Mercury points out the twins, suckled by the wolf, to the shepherd Faustulus. In all the details of the fresco it is the early phase of the myth, and the Homeric type of god, that are presented. Prof. Dall Osso is of opinion that the picture in question is not an original composition, but a replica belonging to the second half of the fourth century, and made from some Greek painting. The fresco is declared to be one of widespread importance, as it supplies a link which is missing in literary tradition.

For six hundred years Switzerland has battled against great odds. This little country, somewhat larger than Massachusetts, but smaller than the State of Maine, with a population equal only to that of New York city, without a harbor, a navigable river, or a lake large enough for commercial use, without a respectable sized farm, without natural deposits of coal or iron, with one-third of its area utterly uninhabited, a second third inhabitable only by the frugal Swiss, and the remaining third only of average fertility, has been obliged to solve economic and industrial questions under the most adverse conditions. Being obliged to import her raw material and export the finished product, she saw that her only hope of success lay in so training her workmen that they could work at the maximum efficiency. This led to a system of scientific education to cover every industry and every profession. In Geneva we find a school of watchmaking; in St. Gallen, the center of the lace industry, a school of lace making; at Brienz, the home of the wood-carving industry, a school of wood-carving. All those little choice bits of carving that travelers bring home with such care were carved by skilled workers, who were trained for their work. And, best of all, there is in Zurich the greatest polytechnic school in the world, which attracts more foreigners, and has more of its graduates holding responsible positions, than any other school in Europe. The industrial supremacy of Switzerland is due solely to her acceptance of the scientific spirit.

Writing on the Origin and Growth of Ripple-mark, Mrs. Hertha Ayrton says, in the Roy. Soc. Proc., that at the starting of the ripple-mark in perfectly smooth sand, it was found that a single ridge forms wherever water happens to have a place of maximum longitudinal velocity during several oscillations. As soon as this ridge reaches a certain height (less than a millimeter) the water flowing over it forms a spiral vortex with horizontal axis, which starts a new furrow and ridge in the lee of the first, on one side during one swing, and on the other side during the next. Vortices arise at these two new ripples and give rise to fresh ripples. When the place of maximum horizontal velocity was constant, not merely for several oscillations but for a considerable time, as at the loop, for horizontal motions, of a stationary wave, the ridge formed grew into a ripple-marked heap which was highest at the loop and lowest at the nodes. By oscillating water in the simplest possible way, so that it alternately rose and fell at one end of the trough while it alternately fell and rose at the other, a stationary wave having its length twice the length of the trough was obtained; and in this case a ripple-marked mound arose of which the apex was at the middle of the trough—one loop of the wave—and the lower part were near the ends—the two nodes. When the stationary wave was of the same length as the trough, two mounds arose, one near each end; and so on. Mrs. Ayrton suggests that the tidal ridges in estuaries and the chains of sandbanks under

the sea are formed in this way, by stationary or nearly stationary water waves; and that the sand dunes of the seashore and of the desert, and the clouds in a "mackerel sky," may be similarly the products of stationary air-waves.

TRADE NOTES AND FORMULÆ.

A New Use for Soapstone.—It is said that melted soapstone can be drawn out into very fine threads, like quartz, which are used in connection with many laboratory instruments. The soapstone threads are subject to very little variation, and are therefore well adapted for the suspension of certain fine physical apparatus.—Seifenfabrikant.

To Polish Old Carvings.—Mix 500 parts, by weight, of linseed oil, 500 of English ale, white of egg in the proportion of the white of one egg to a pound of the oil, 32 parts of French spirit and 32 of aqua ammonia, and shake the mixture thoroughly. For use, pour a few drops upon a piece of old linen and apply to the article to be polished. Afterward rub with a silk cloth. This liquid will keep a long time if the bottle is well corked.—Maler-Zeitung.

Black Stain for Hardwood.—For a black stain on hardwood, the following is recommended: 20 parts, by weight, of anilin hydrochlorate, dissolved in 300 parts of water, to which solution is added 1 part of copper chloride. Apply the liquid hot. After it has dried, apply a second solution, consisting of 20 parts of potassium bichromate in 400 parts of water. This stain has great power of resistance, even against acids. —Holzmarkt.

Fillings for Delicate Hollow Sheet-Metal Work.—Articles made of sheet metal, also jewelry and goldsmith's work, must frequently be filled with some substance to protect them from being bent or dented. Various means are employed, but even the best known of these are liable to serious disadvantage. Rosin, melted and poured in while hot, is a filling frequently used. It congeals very rapidly even when poured out in a thin stream; it will not therefore completely fill narrow hollows, and the object is only imperfectly attained. It also crumbles very easily and is not very durable by itself. Rosin cement, or mastic cement as it is called, is therefore much more often employed as a filling for hollow sheet-metal products. This cement consists of nothing but rosin, whitening, and a little petroleum. The rosin is melted and dry whitening sprinkled on it through a fine sieve and the mixture well stirred. The whitening must be added to the boiling rosin till the latter is thoroughly saturated with it. Some petroleum is then poured in and the whole again well stirred. A little of the cement is then taken out with a spoon and poured in a thin stream on a metal plate, as is done with tin solder. It will harden immediately, and as soon as it has become cold it is taken up and tested for brittleness. If there is too little petroleum in the cement, it will be very brittle; more petroleum is accordingly poured in. If there is too much petroleum, the cement will be soft and pliable; in this case more rosin and whitening must be added. If it shows the right degree of hardness, the cement is poured out in tablets and kept for use. An operator can save much expense by preparing this cement himself. If properly mixed, it is admirably adapted for many purposes.

Another method of filling hollows in metal work consists in the use of gypsum. This is always unsatisfactory and should be avoided. It contracts considerably while drying, and then rattles about in the hollows which it is intended to fill snugly.

Sulphur is a filling which may be recommended in many cases, though its use is not very agreeable on account of the suffocating fumes developed. It makes a tight filling, as it does not contract, but its use is much restricted. Fine sand is often employed; it has the advantage that it can be applied cold and dry, which is the case with no other filling.

In addition to filling up the hollows it is often required to cement the article to a pin. In such cases either the above cement or alum should always be used.

The following is the best method of cementing hollow articles to pins. The article is held in the left hand, using a woolen rag for this purpose, and the cement poured into it from a metal spoon (compressed in front so as to form a narrow channel) till it is completely filled. The cement is then poured back into the vessel from which it was taken, and the article placed on the pin. Enough cement will be left in the hollow to fill up the space between the pin and the metal, and a little will also appear around the point of junction. If any cement should find its way onto the exterior surface of the article, which is sometimes unavoidable, it can be removed with petroleum. The latter softens the cement, which can then easily be detached without injuring the surface. The best of all fillings is alum, melted and poured in like the rosin cement. It has the advantage of flowing perfectly, hence the finest chased work can be thoroughly and tightly filled. Moreover, it becomes as hard as stone and does not contract or crumble away. On the other hand, its use is attended with this drawback, that as a cement it is inferior to rosin. If it is desired to use alum for filling hollow articles which are to be fixed to pins, the latter must be provided with notches in which the alum may set, in order to offer sufficient resistance. Good results may also be obtained in many cases with gypsum or water-glass. The important point is to learn to choose the means best adapted for the purpose in view.—Die Edelmetall Industrie.

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